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Plastics

ALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

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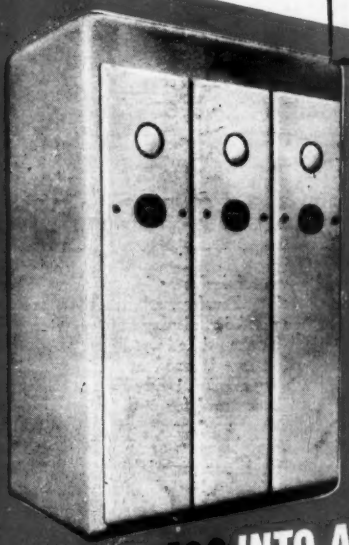

TURNING AN EGG INTO A CHICK

This is one of several jobs which Plastics seem to do better than a hen. For example, Beetle-Bonded plywood is used exclusively for the outer casing of the new Western incubator. This plywood bonded with Beetle Cement is strong and light; it is required to withstand conditions of 60% humidity at 100° F. and to keep mould and vermin at bay. Western Incubators Ltd. of East Hanningfield, Chelmsford, Essex, have produced a good many new ideas for incubating chickens, while B.I.P., of course, are always ready to incubate new ideas for any industry—and hatch them out.

ITISH INDUSTRIAL PLASTICS LIMITED B·I·P GROUP 1 ARGYLL STREET, LONDON, W.1

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Every branch of industry has a thousand uses for Trapinex Paint Transfers, additional to the more obvious uses for publicity, display and packaging—the "painted" word for the printed word wherever required on glass, plastics, metal, wood or any other smooth surface. The easily applied, ready for use, transfer has for many years been used for products as diverse as cosmetics and heavy machinery.

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B

Meeting employers' demands for men of executive standard

WHEN millions of men came home after the first world war, there was no adequate machinery to help those of talent or experience to find jobs worthy of their ability—or to help employers to find *them*. The result was a vast amount of human waste and frustration, tragic for individuals and a serious loss to business and industry.

Once again the Forces and war industry are releasing thousands of men and women of superior ability—some with special qualifications, others with good executive experience. And there are also many high-grade younger men, called up before they were well started in business or industry, but now matured by war, and with the qualities of initiative and character that employers seek.

But this time a free appointments service, on a nation-wide scale, is helping to put employers in touch with the men and women they need for executive, managerial or administrative positions.

FINDING THE RIGHT MEN

The work is decentralized, in thirteen Regional Appointments Offices, so that all candidates for responsible posts can be interviewed and their abilities classified. Those with no previous experience in their chosen field are assessed and " screened " by modern, tested methods to reveal special aptitudes.

In this way the employer is spared many fruitless interviews—since *only* promising candidates are submitted for his selection. And to find a man with the right experience for a particular post, or the right talents to train, he can draw on the whole country if need be.

It is NOT the task of the Appointments Offices to find jobs for all applicants, regardless of ability: the aim is to see that capability and experience are not wasted, and that employers have a choice of the best candidates available for responsible posts. More than 30,000 such positions have been successfully filled since VE-day.

GOVERNMENT-ASSISTED TRAINING

Whether you need a man who is already qualified and experienced, or are looking for a promising young man to train, it is highly probable that the man you are seeking is now on the Register of one of the Appointments Offices, or will be as soon as his release group is reached.

Or he may be among the men training under one or other of the Government's Training Schemes — the Further Education and Training Scheme, by which men are assisted to complete their professional or technical education—or the Business Training Scheme, which gives to selected men of potential management calibre a training in business management, including practical training within a firm, coupled with financial assistance where necessary while training.

In any event, if you will give your Regional Appointments Office an indication of your needs, every effort will be made to find the man you want.

Write, telephone or call. The Regional Appointments Offices are in the following towns:

LONDON: 1-6 Tavistock Square, W.C.1
CAMBRIDGE: 5 Salisbury Villas, Station Road
READING: 23 Valpy Street
BRISTOL: Lyndale Hotel, Berkeley Square
BIRMINGHAM: 239 Broad Street
NOTTINGHAM: Commerce Chambers, Upper Parliament Street
LEEDS: Greek Street Chambers, Greek Street
MANCHESTER: Commercial Chambers, 47 Corporation Street
LIVERPOOL: Cotton Exchange, Bixteth Street
NEWCASTLE-ON-TYNE: 153 Barras Bridge
EDINBURGH: 5 Rothesay Terrace
GLASGOW: 450 Sauchiehall Street
CARDIFF: 8 Cathedral Road

A Manufacturer's Thanks

Employers have been quick to appreciate the work of the Appointments Offices. The following, from a firm of manufacturing chemists, is representative of many such letters received:—

"I would like to express my sincere thanks to your Department for the excellent service which you have afforded me. It is my considered opinion that the selection of applicants by you shows excellent judgment and a considerable amount of skilful work."

Issued by the Appointments Department, Ministry of Labour and National Service, St. James's Square, London, S.W.1

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

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now DISTRENE foil

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DISTRENE Regd. (Polystyrene) was the material that completely met these needs.

Now, in the change over from war to peace, you have your problems of high-frequency radio and electrical insulation. DISTRENE FOIL can help you to surmount them.

In DISTRENE FOIL (Orientated Polystyrene Film) the molecules are specially arranged during manipulation so that the tensile strength is increased by 3 times and the flexibility by 10 times.

Power Factor
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Tensile Strength
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Thickness
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1 SAVES FUEL
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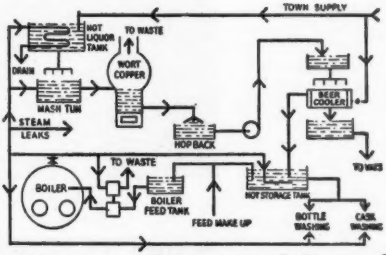
How does it achieve such noteworthy results?

Briefly, it is a practical method of integrating your heat-using processes, aiming towards operating them as a single co-ordinated heat-using plant. With Thermal Linkage, total heat will no longer be independently supplied to the several separate points of consumption. Instead, heat is systematically circulated from point to point, achieving maximum work, minimum waste.

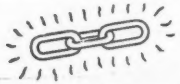
THERMAL LINKAGE SAVES BREWER 46% OF HIS COAL

METHOD USED: Direct-fired copper converted to steam-heating. Heat exchanger installed to utilise vapour from copper. Para-flow cooler incorporated, allowing cooling water to be heated direct to 135°F. Steam coil in liquor tank trapped and all condensate returned to hot well. Steam leakages stopped. Exhaust from boiler feed pump passed through coil in the hot well. At hot-well temperature of 185°F. all condensate diverted into hot-water storage tank by thermo-regulator.

FOR COMPLETE DETAILS SEE "FUEL EFFICIENCY NEWS," JANUARY, 1946.



Before a small brewery used 13 tons of coal weekly to produce 70 barrels per day.

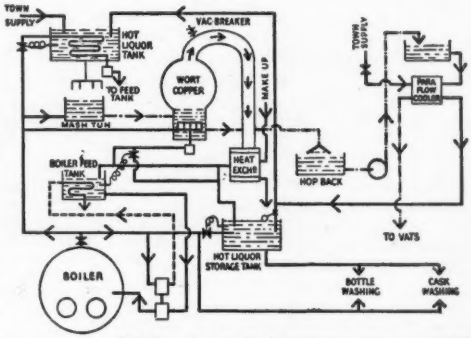


Consider Thermal Linkage NOW

The need for fuel efficiency is pressing and will remain so. If the principles of Thermal Linkage are not being applied to your plant, go into the matter *now*.

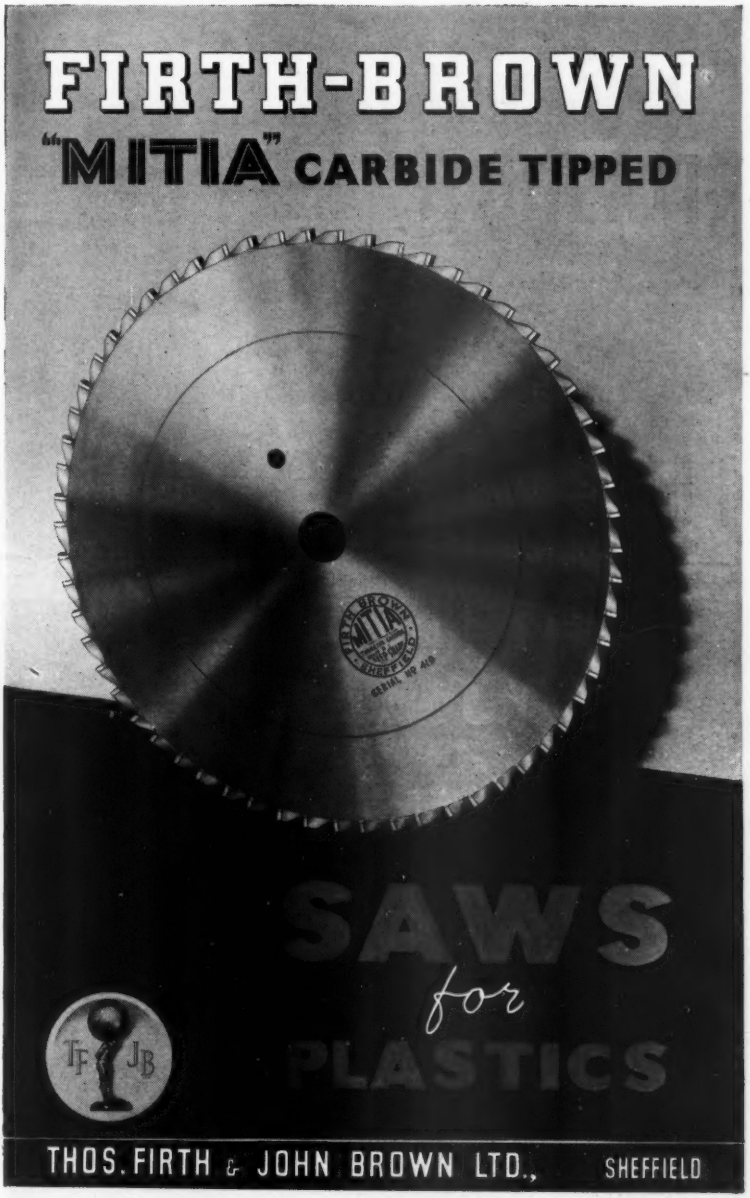
FOR GENERAL INFORMATION see Fuel Efficiency Bulletin No. 21 (The Construction of a Factory Heat Balance).

FOR SPECIFIC ADVICE and guidance contact your Regional Office of the Ministry of Fuel and Power.



After the same brewery for the same output consumed only 7 tons per week.

ISSUED BY THE MINISTRY OF FUEL AND POWER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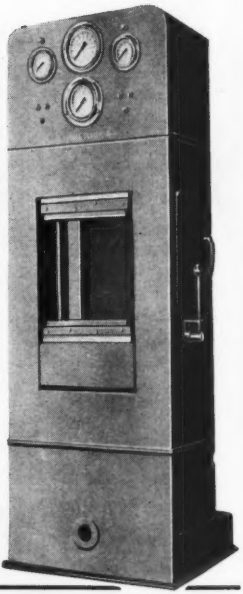

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P.5

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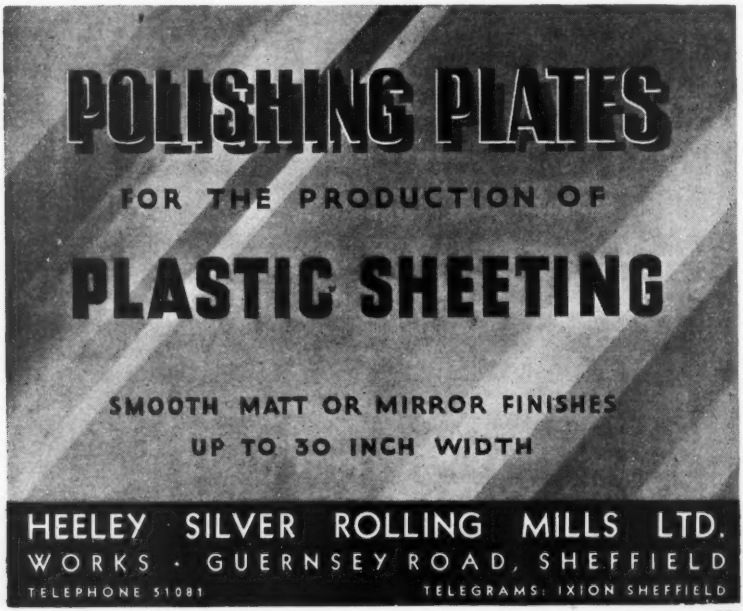

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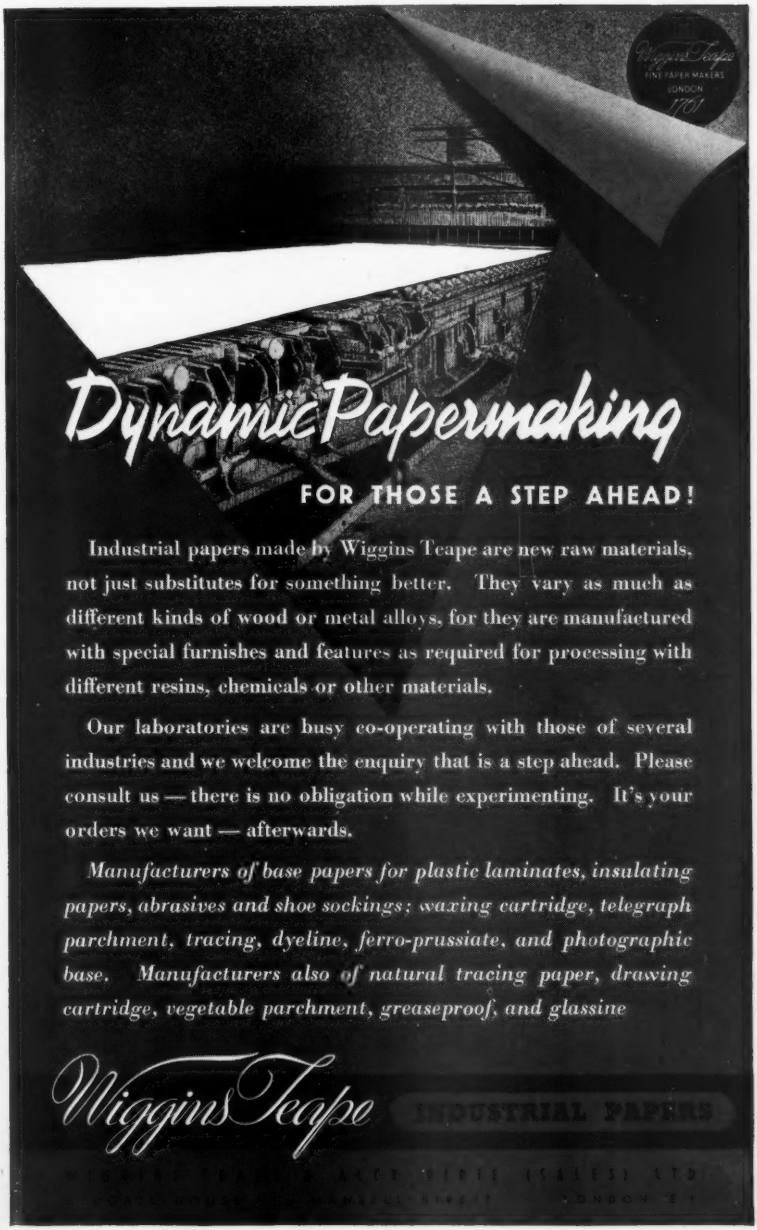
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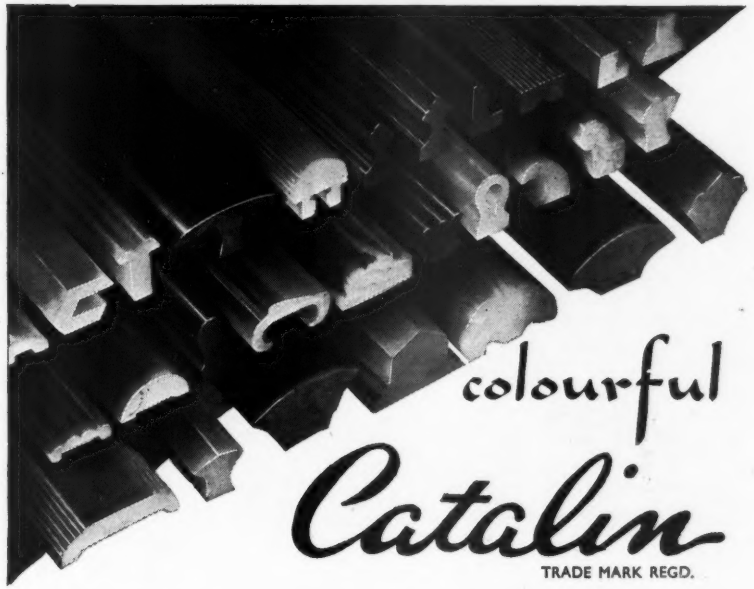

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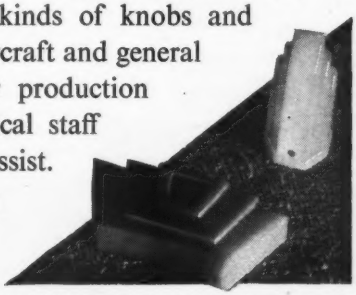
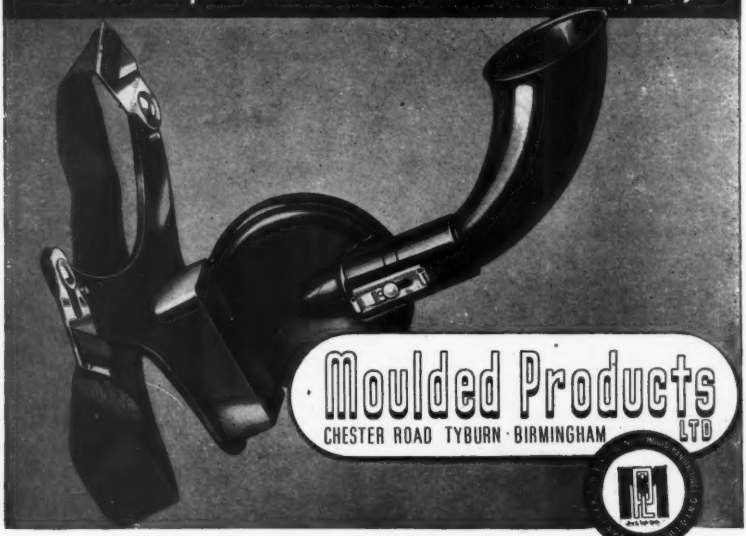


CONTACT: CATALIN LIMITED (DEPT. P.) WALTHAM ABBEY, ESSEX. *Tel: Waltham Cross 3344*
6

From the simplest MOULDING to the most complex job



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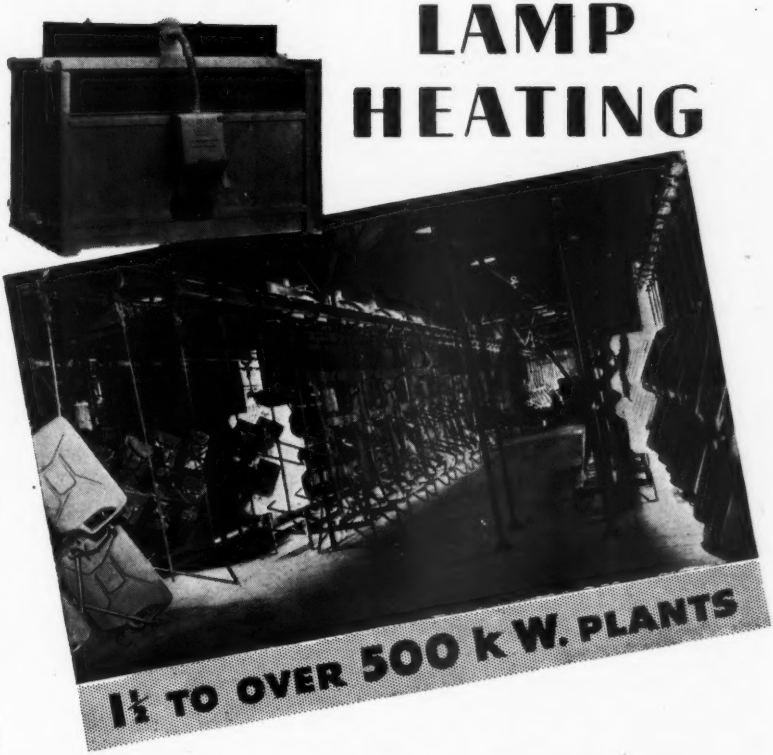

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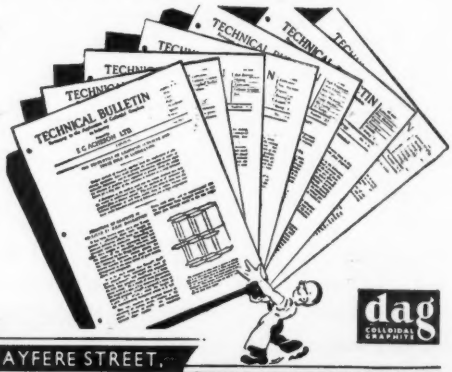

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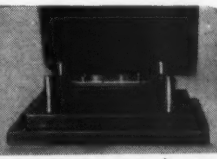

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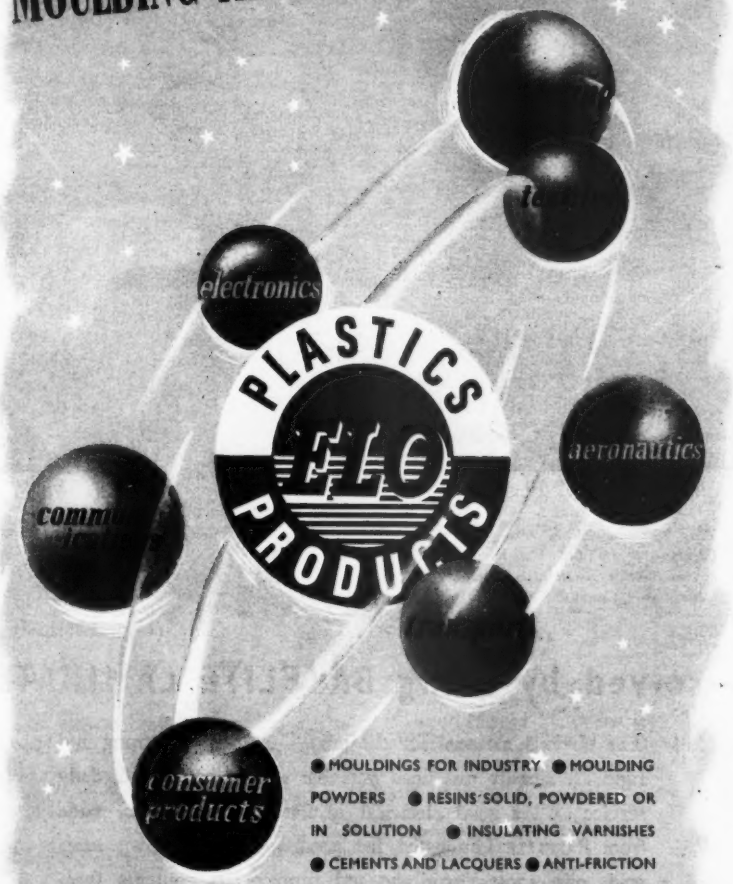

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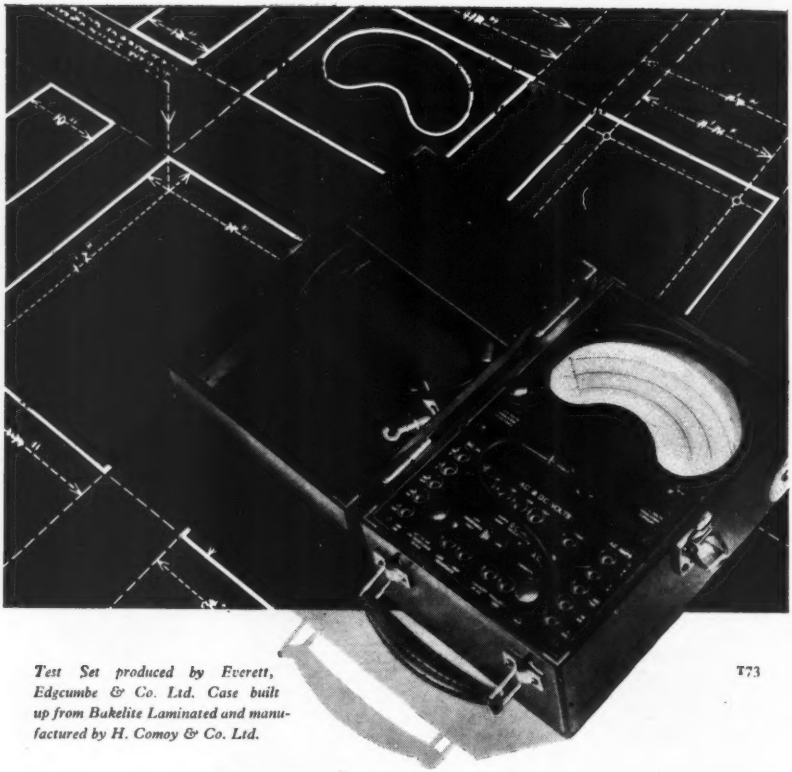

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Vol. X. No. 111. AUGUST, 1946.

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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NOTICES

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EDITORIALS

Words . . Words . . Words

MR. CLARK RAMSAY'S letter in our correspondence pages on the use of the words "plastic" and "plastics" refers to a subject which is as delicate as it is difficult. We are timorous of entering realms where more angelic feet fear to tread merely because we are not grammarians, etymologists or lexicographers, nor are we of the select band of bibliographers who understand the Universal Decimal Classification. It is they, no doubt, who will decide officially the acceptance of such words.

However, words are part of every man's life and we must take an interest in them. First let us see what the dictionary says about them. Prior to 1944 the word "plastic" existed only as an adjective and meant the property of being plastic or mouldable. There was no noun, singular nor plural.

To-day, the noun "plastic" is accepted and is included in the addenda to the Third Edition of the Shorter Oxford English Dictionary (1944), and is a "synthetic resin or other substance that can be moulded into any form." On the other hand, "plastics" does not occur, but surely must be accepted as a simple plural of "plastic." Thus we should be allowed to say: "The synthetic resins, polystyrene and phenol-formaldehyde resin are plastics."

So far, if the above be accepted, Mr. Clark Ramsay will agree that that section of the plastics industry which produces the raw materials for the moulders are, in truth, manufacturers of plastics, since they are mouldable. He will also agree that the definition in the O.E.D. must signify that a plastic is a material that may be mouldable by heat and pressure, since synthetic resins are, in general, not mouldable without such outside influence.

So far we will all agree that the O.E.D. has accepted the noun "plastic" so far as it concerns raw material for the plastics industry.

What of the mouldings manufactured by the moulders from plastics? Should we call them plastics or not? Here we sympathize with Mr. Ramsay, but not wholeheartedly. He states, "Except in few cases, the product is rigid and far from plastic."

His premise here of a rigid body being non-plastic is surely incorrect, since rigid objects made from, say, polystyrene, or indeed many thermoplastic resins, are always plastic and can be remoulded if desired. Rigidity is not a definition of non-plasticity.

His argument obviously refers to moulded objects made from thermo-hardening resins, and we must examine his words "few cases."

We insist that a very great many objects made by moulders are rigid and are plastic; we refer to those made from thermoplastic resins. About seven years ago, thermoplastic resins formed about 16 per cent. of the raw material of the plastics industry. To-day they form over 30 per cent. of it, and this does not include the synthetic rubbers or nylon or polyvinyl sheet or other vinyl compounds. In fact, the truly plastic finished goods now form a very appreciable proportion of the total output, and may one day prove to be the greater proportion. If this be so we shall be back where we started from, say, in 1910, when the greater number of mouldings (outside ceramics, etc.) were truly plastic. In this connection we may point out that patents on thermoplastic resins are about three times as numerous as those dealing with thermosetting resins.

On the whole we wish thoughtful men like Mr. Ramsay had been on hand 20 or 30 years ago and had coined an entirely new and fabricated word

to cover the manufactures of our industry. That would have solved the whole problem, and we should have avoided much argument and perhaps much harm to the trade. Is it too late to find one now?

In passing, we are wont to regard the French, German and Italian as being more logical than ourselves and the Americans in this nomenclature affair. "Matières Plastiques," "Plastische Massen" and "Materie Plastiche" are correct scientific designators. It is almost amusing to find that the French have capitulated by entitling their best-known journal on the subject "Industries des Plastiques," thus making a noun.

On the whole, we agree that it is desirable to distinguish between raw materials and finished goods, and "plastics" may well do for the latter. Perhaps, who knows, the use of the word "plastic" may become obsolete and save us a lot of trouble.

When we wish to be cynical, many of us make our own definition of plastics: any material used by the plastics industry. Can we not, since we are a very powerful industry, throw the onus on to the physicists and ask them in future to stick to rheology and "rheo-something or other," an adjective meaning "mouldable or giving form to clay, etc."

Plastics Fogbound

WE have a certain sympathy with many users and, indeed, many manufacturers, who, in effect say, "Why all this pother over names? Whether we call the stuff plastics or X-ite or Y-ene or Z-ol, we give the customers what they want. The public that buys radio-cabinets or electrical goods or knife handles of plastics knows that they're not made of putty, but of a hard, strong material. When they want plastic sheet for making curtains, we give them what they want, namely, p.v.c. or similar material, and the public knows in this case that plastic sheet is soft and smooth, waterproof and colourful and transparent or opaque; in fact, just what it wants for curtains or macintoshes. The public is learning slowly and is perhaps confused when it thinks but, nevertheless, it is learning.

There is some horse sense in this argument, but it is only horse sense.

The desire for proper nomenclature and classification is not merely one for uncontrolled sophistication, nor for the joy of adding another word to a dictionary, nor to add yet another table to the literature to flaunt one's erudition. The bibliographers and the classifiers of the world need no explanation of their "reason for being" by us.

Even the man in the street knows, however vaguely, that their work has resulted in order within the sciences of botany, zoology and geology, to mention only a few, and that the world has benefited thereby in many ways. So it is with all sciences, and unless these aids are brought in to define the limits (if limits there are!) and divisions of the plastics industry, progress will be slower than it should be and chaos more chaotic. At least they place in the hands of the scientists one of the tools for improving our raw materials, and that is a matter which does concern the manufacturer and, finally, the user.

That the plastics industry is ready for such action some strenuously deny. At least we should make an attempt to clear some of the fog.

In the extremely valuable paper entitled "Plastics, their Nomenclature and Classification," by Reynolds and Silvester, which we mentioned in our May, 1946, issue (page 227), the authors quote: "As an instrument of record, language must possess two principal requisites:—

"(1) Precision of meaning: so that every general name shall have a certain and knowable meaning, i.e., the connotation must be fixed.

"(2) Completeness."

Most of our readers who have had sufficient experience of the plastics industry may have their own ideas as to the possibility of fulfilling such requirements.

Coal Research

OUR gratuitous remarks last month on the duties of a Minister of Fuel on a consideration of the coal industry reminds us of what we believe to be a curious orientation of mind by plastics technologists regarding phenolic resins. We as an industry are not always as searching as we might be.

During the past 35-40 years research has revolved around their manufacture almost solely for the production of moulded goods by mass production. This means that pure carbolic acid, which gives the most rapid curing resins, became a standard and that any phenol that gave resin of longer curing time was regarded with good reason as being inferior or at least undesirable. It is true that the cresols were accepted after a period, but the xylenols and the phenols from low-temperature tars found little or no acceptance except during the late war.

It thus became axiomatic that any phenol which, on resinifying, gave a long curing time, did not harden, or was too costly in comparison with carbolic acid, was rejected and no further work was done on it.

It is obvious now that a good many opportunities were lost in not continuing with the research to find out what use could be made of these recalcitrant resins.

Two object lessons before us are the resorcinol resins and the butyl phenol resins. The former, as a result of American research, has proved of great value as a low-temperature curing resin especially applicable as an adhesive. The makers prophesy a considerable lowering of price in time.

The second example is that of butyl phenol, which has long been condemned as giving soft, rubbery resins. This property the Germans took full advantage of during the war to produce one of the best tackifiers for synthetic rubber.

We presume there are many other phenols, poly-phenols, chlorinated phenols, thymols, guaiacol, etc., which might be worth thorough examination.

GERMAN PATENTS

A CONFERENCE to consider the question of future treatment of German-owned patents in Allied countries took place in London, July 15 to 27. The chairman of the conference was Sir Harold Saunders, Comptroller of Patents in the United Kingdom.

Complete unanimity prevails among the United Nations that in no circumstances shall any such patents within their territories revert to the former German owners, and the question as to how such rights shall in future be disposed of presents many difficulties. A strong sentiment prevails that it would be unfortunate if the continued existence of these patents should constitute an obstacle to international trade.

As a result of the discussions, the representatives of France, the Netherlands, the United Kingdom and the United States have signed an accord which will have the effect of making all patents of former German ownership now controlled by their Governments (and in which there is no non-German ownership now controlled by their Governments, and in which there is no non-German interest existing on August 1, 1946) available within their respective territories to all nationals of the countries party to the accord without payment of royalties or without any requirement to manufacture within the country where the patents exist. The representatives of Australia, Canada, Czechoslovakia, and the Union of South Africa have agreed to recommend to their respective Governments that the accord should also be signed on behalf of those Governments.

RESEARCHES IN CANADA

According to the 28th annual report of the National Research Council of Canada, for the year 1944-45, published at Ottawa, a small group of workers in the Chemistry Section have been engaged on fundamental studies of long-range interest to synthetic rubber manufacture.

In the Plastics and Colloid Section, the chief projects related to the study of density-temperature relations of some plastic materials and the physical properties of plastic and plasticizer combinations. The Plastics Testing Laboratory carried out investigations on waterproof maps, testing of safety goggles, the treatment of leather components for use in the Tropics, the improvement of sole leather by impregnation with resins, and the examination of periscope prisms to determine the reason for bubble formation in the plastic laminating layer.

FRENCH LEAVE

"J'ai deux amours,
Mon pays et Paris."

—Music-hall song.

ON the stroke of 10 a.m. "The Golden Arrow" surges out from Victoria Station on its way to Dover. It is a very special locomotive with a few coaches designed for those who wish to travel "en prince." By prince we mean the new royalty, too, as O. Henry used to describe it—the Kings of Collateral, the Princes of Plastics, the Government Viscounts V.I.P.s and the Barons of Beef.

It is the last word (until the next be said) of travel in comfort. Lucullus would have been quite content, for there is also the Trianon Bar.

We have already described this bar in a previous issue following a Press view, when it had arrived in London after one of its journeys, stationary and alone.

It is too late now, but the sponsors of the visit should have treated the journalists to a short trip to Dover—or to Paris. The visit to a static coach is not enough. Let us go back to 9.45 a.m. on any day to see the reason why.

We are ushered into our seat in the Pullman coach by a pleasant-looking master of ceremonies, who whispers that he is glad to see us back again on the European "run"—a delightful fiction satisfactory to both parties.

It is a comfortable seat—a velvety, colossal seat in which to roam about, and we relax. We gaze about and the scene seems somewhat familiar. We get that "we have been here before" feeling until you suddenly realize that it is all a cross between the sumptuousness of the long-vanished Adelaide Rooms in the Strand and the solid riches of, say, No. 245 Park Lane or thereabouts in the time of the South African millionaires.

From the depths of our coach our eye pauses restfully on the snowy napery and silver before us. A small lamp, ornate in brass with a pink silk shade redolent of Soho nights, stands discreetly at our elbow. We gaze at the walls of costly woods, dark and richly laid with multi-coloured floral designs, the pride and joy of some vanished race of miracle woodworkers. The walls are fitted with ornamented brass candelabra, the doors with beautifully intricate brass handles. We wonder idly what the cost of building all this was and the number of man-hours spent in cleaning and maintenance.

And then we remember that in the early days of the century the railway companies had decided, for some reason best known to themselves, that the temporary, but paying, guests should be transported in the condition to which they were accustomed; at least maintained under the illusion that it was all "a home from home." We gaze up to the

ceiling anxiously expecting the familiar chandelier.

No, there is no chandelier. Perhaps there once was one. If so, it has been replaced by—yes, it is, a loudspeaker!—for soon there is a click, a gramophone sort of noise and Alvar Liddell (or is it Bruce Belfrage?) wishes us good morning and announces that "The Trianon Bar" is now open for our amusement and refreshment.

The day is hot and we rise and leave the 1880s, open a door, take two steps and we've walked slap into the 1950s or thereabouts. We are in "The Trianon Bar."

As we have already said, we described the bar in a previous issue; the clean, lovely austerity of the dove-grey panels of laminated material, relieved by the gaiety of a pink and white motif; the whiteness of the tabletops and counter, and the beauty of the transparent plastic vessels and lighting equipment. We leave other comparisons to our readers and to the railway companies, and merely wonder how long it will take to transform the whole train.

At Calais the luxury train to Paris is named the "Flèche d'Or" and is almost a replica of "The Golden Arrow," except that the furnishings are definitely Second Empire or Café Marguéry, 1905, which is about the same thing, and that there is no Trianon Bar. In fact, there are no plastics at all, with the exception of the loveliest table lampshades we have ever seen, fashioned from what looked like Chinese amber, 1/32 in. thick and very strong and tough. In Paris, and in another train, we saw again the moulded "occasional" drop-tables of moulded phenolic resins in the carriages we had seen in 1938.

Calais is laid flat, and this ancient town, so much tied up with British history ancient and modern, looks like the district around St. Paul's multiplied a dozen times, and not yet cleared up—we did not see one house intact. However, as we are among those who believe that no foreign country has suffered so much as England, and no town so much as London, we don't quite believe what we saw.

And so on to Paris, which remains physically untouched and as lovely and as clear-eyed as ever. We had come on a very short trip, more especially to return the compliment of the recent visit to us in London of the Editor of "Industries des Plastiques," Monsieur P. Dubois. He told us of the difficulties that industry had laboured under during the occupation, and the part so many had played in slowing down or stopping production for the Germans. As for present matters, his main points corresponded with the story Professor Denivelle had told us last year at the Institute of the Plastics Industry meeting.

Lack of raw material has slowed down production in all spheres. France is working harder than ever it did, and the French were never a lazy people, so that recovery, when industry gets into full swing again, will be rapid. Lack of cotton has affected celluloid and acetate production very greatly, and since the milk situation is serious (we did not see any of the stuff during our stay—it is distributed only to the very young and the very old) there is little casein available—and imports are difficult. Similarly, the appalling coal situation, far worse than in this country, has affected every sphere, thermosetting and thermoplastic resins and, of course, plasti-

Lipstick holder of transparent plastics. (Elizabeth Arden.)

Vanity case fabricated from ivory-white striated sheet and hand-painted. (Jacquemin-Blériot.)

cizers or resins derived from naphthalene. It is interesting to note that, during the war, a low-quality plasticizer was made from coal tar residual oils, such as anthracene oils, when none of the usual esters was available.

Nevertheless, as soon as coal and imports are freer the research carried on during the war years will bear fruit. Much of this has revolved around acetylene, which France produces mostly near her sources of hydro-electric power, and much interesting news is expected in novel applications of vinyl compounds, chloride, acetate, formal, butyral, and so on, for a variety of purposes ranging from artificial leathers, floor covers and acid-proof fabrics to new glues, belting and gramophone records. The Société St. Gobain, more famous for glass making than plastics, is producing silicone resins. Injection moulding has been adopted very widely, one company in Oyonnax possessing 35 modern machines in one factory. Another concern in Lyons is injection-moulding with nylon, which means that the French have not allowed the grass to grow under their feet.

The lack of raw material showed itself visibly in one way. Very few shops show any p.v.c. sheet or raincoats, aprons and the like made from it. Likewise, we saw no cigarette cases or boxes or trinkets made from methyl methacrylate or acetate. Some shoes, however, were obviously made from p.v.c.

Nevertheless, we expect to see soon much of the work of the French designers in the realm of fancy goods. We picked up two examples which struck the eye; the first, a lipstick container of spirally moulded transparent material—an Elizabeth Arden production by the French company, which looks much better than the black-and-white photograph shown here. The second example is a vanity case of outstanding loveliness, made (so the girl at "Les Trois Quartiers," near the Madeleine, told us) of Rhodoid, which is, of course, a product of Rhône-Poulenc, who, before the war, had the reputation of making superb acetate. We suspected casein merely because it was a striated material normally associated with casein and made by compressing alternate transparent opaque sheets. Whatever the material, the makers of the case (Jacquemin-Blériot is stamped on it) are to be congratulated. The material looks as if it had been cut from solid ivory and bears a hand-painted design of roses in red and green. We note that the artist (Osmont) has been sufficiently proud of his work to sign it with his name. The price was 410 francs (17s.) and was worth double.

There is also another point worth noting, namely, the ingenious method of hinging the lid. A gilt pin runs through seven sections of transparent plastic tubes—and that is all one can see—no metal flanges and no screws. Presumably there are additional pins, but they were quite invisible.

This was a little thing, but it was worth while going to Paris to see. M.D.C.

P.S.—Nylon stockings are available at the ridiculously low "knock-down" price of 2,000 francs (4 guineas) per pair!

The Microscopic Examination of Plastic Materials

VI.—Mouldings: (b) Fillers (Coconut Shell Flour)

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

Here the author deals with the structure of coconut shell. He shows how the tracheids break down under grinding, and points out that the structure of the resulting flour has pronounced effect on the flow properties of moulding powders into which it is incorporated as a filler.

WE have seen that wood flour sets certain limits to the electrical and mechanical properties of a moulding. In general it may be taken that whatever the filler used, limiting factors in one or more directions are encountered; in other words, the ideal filler has yet to be developed. There are, however, other woody materials which seem to offer scope in the improvement of the general characteristics of electrical mouldings. These are the shells of both "dicot" and "monocot" fruits, and for our examples, suppose we examine the possibilities offered by coconut shell, as a typical representative of monocot fruits, and the walnut shell representing dicot fruits.

Let us, then, see what the coconut has to offer us in the way of a material suitable for filling purposes; but before going into this question, first consider the nature of the article. The coconut is the fruit of the coco palm, and may be considered as being composed of two distinct components, these being the husk or fibrous portion, which serves to cover and protect the seed or nut proper.

In brief, the husk is composed of long, heavily lignified fibres bound together by a cork-like cement substance, in which the well-known "coir" fibres are embedded. When disintegrated and separated from the fibres, this cementing material is called coir dust. Thus we have this tough outer covering to the seed, which in turn is composed of the familiar hard shell, which is lined with the succulent nut meat.

For our examination, the shell is the only constituent to come under consideration at the moment. This tissue would appear to be laid down originally as fibres, not orientated in any particular direction, but crossing one another at many different angles, from which one could very well imagine the building up of a dense and strong network, upon which heavy lignification would produce a consolidating effect, evident in the mature shell. Thus in Fig. 104 we see a photomicrograph of a transverse section of a portion of coconut shell at a magnification of 110 diameters, which clearly illustrates the fibrous nature of the shell and shows it to consist of masses of

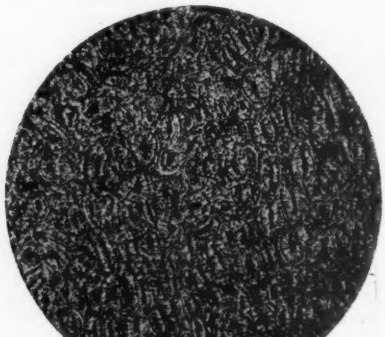


Fig. 104.—Transverse section of coconut shell. Mag. 110 diameters.

Fig. 105.—Longitudinal section of coconut shell, showing the tracheids. Mag 110 diameters.

Fig. 106.—Longitudinal section of coconut shell, showing "bundles" of tracheids. Mag. 110 diameters.

closely packed and greatly thickened tubular vessels, which may be compared to tracheids or bast fibres. It will be noticed that the lumen or bore of these tracheids is quite small when compared to the external diameter.

The majority of the fibres shown in this illustration are seen in true transverse section, but there are some cases where the fibre section is distorted, due to the section being taken at an angle to the long axis, thus signifying that the fibres are not parallel; in some portions of the section this condition may be seen in the extreme case. This is very well shown in Fig. 105, which is a photomicrograph of a longitudinal section of coconut shell, again at 110 diameters. This illustration shows that the vessels are in reality tracheids, as they are of comparatively short length. Also, it will be seen that there are numerous tracheids whose direction is at right angles to those seen in longitudinal section; two such vessels are indicated at "A"; others whose direction is not at such a large angle may also be picked out. In general, it is clearly shown how the tracheids are laid down in many different directions, thus building up the aforementioned lattice or network.

This network is not necessarily built up of single tracheids interlacing with one another; this also occurs in numerous places between bundles of tracheids. This is illustrated in Fig. 106, being a photomicrograph of another portion of the same section illustrated in Fig. 105 and at the same magnification. Here we see the presence of bundles of tracheids lying at right angles to the main direction; two such bundles are illustrated at A and B.

A study of the foregoing illustrations will show that in the structure of the coconut shell we have an excellent example of the manner in which the orientation of a fibrous filler will increase the general strength of a moulding. For if we look upon the basic fibres as the filler and the ligneous material as the resin, we see how each filler particle is virtually cemented to its neighbour by the resin, and at the same time embedded in a continuous matrix. The significance of this structure lies in the way it is laid down, because the lignin and basic cellulose, if taken individually, would not produce the strengths obtained when they are combined in this manner. The lignin itself would appear to be extremely brittle, but when in the form of a binder, such as we have in the coconut shell, this is somewhat offset by the presence of the cellulose, the resultant structure being hard and tough, although still rather more

Fig. 107.—Transverse section of coconut shell. Mag. 445 diameters.

brittle than is the case with true woody structures.

However, as the function of the shell is to protect the delicate endosperm or kernel from damage and to allow it to develop and mature, it will be seen how admirably Nature has designed and produced the right material for the right purpose.

Having obtained a "bird's-eye view," as it were, of the structure of the coconut shell, let us now examine it at somewhat closer quarters. In Fig. 107 we see a transverse section of the shell at a magnification of 445 diameters. This illustration clearly shows several tracheids in cross-section, as at A and B, from which an idea of the magnitude of the lignification may be obtained. The thickening of these tracheids is very high; for example, planimetric analysis of A and B indicates that the wall thickness occupies some 90 to 95 per cent. of the cross-sectional area of these two tracheids, and it may be taken that in general this thickness is in the region of 90 per cent.

Now let us examine the nature of this lignification. Much has been written of lignin as applied to plastics, and a great deal of work has been done on the chemistry of lignin, but up to date its true nature and the forms in which it is laid down by plant tissues are still somewhat of a mystery. However, it has been more or less definitely established that in the early stages it is developed in the cellulose wall as a ligno-cellulose compound of extremely complex and, at present, unknown molecular structure.

It is probable that when lignification takes place without a large increase in the thickness of the original cellulose wall, the entire structure exists as ligno-cellulose. On the other hand, in cases such as the one under consideration, where the original thickness of the cellulose wall is greatly increased, the probability of the excess lignin existing as such, and not in combination with cellulose, must not be overlooked, as it seems probable that in such cases this development of two materials does occur. Thus, on referring to Fig. 107, we see that in all cases the tracheids show two distinct zones in cross-section, indicating the existence of a relatively thin outer layer such as shown at C, and a massive inner layer as indicated at D. This structure would appear to demonstrate the existence of two different materials which is proved by the difference in refractive index shown by the presence of the interface where they meet.

From this it would appear reasonable to suppose that the lignification of the coconut shell tracheids takes place in two stages, the first occurring in early life and involving the development of lignin in the original cellulose wall in the form of a compound, which, for lack of a better term, we call ligno-cellulose. The second stage is that of the further addition of lignin after the lignification of the cellulose wall has been completed; this further addition appears to be uncombined lignin producing massive thickening and conferring great strength on the general structure of the shell.

If the foregoing conjecture is correct, it would appear that, in the case of highly lignified materials, there would be present a large proportion if lignin in an active form; therefore we would be justified in assuming that, in so far as the utility of lignin as a reactive material is concerned,

its nature and availability are of greater importance than the actual quantity present, for if it exists entirely in the combined state, it is clear that its reactivity will be considerably reduced and it will function solely as a strengthening medium to the filler particles.

It will be appreciated that mechanical strength alone is very desirable in a filler, but if we could have this strength together with a degree of reactivity, then a much more desirable condition would exist, inasmuch as a portion of the filler particle would be taking part in the curing reaction with the resin, and the possibility of an actual fusion at the filler-resin interface becomes apparent. This will, of course, result in a bonding of the filler to the resin.

Let us briefly consider the possibilities of the reactivities of lignin. It would appear that, in the first instance, lignin is built up by condensation from a unit of the propyl guiacol or propyl syringol type, which occurs through various reactions involving phenolic groups, substituted propyl side chains and, in some cases, the benzene ring, ending in the production of compounds containing three-dimensional linkages.

These lignin compounds may be separated and purified; this results in the production of a lignin resin containing reactive phenolic groups, therefore it is reasonable to suppose that if the lignin in pure form does exist in structures like the coconut shell, then we may expect the presence of reactive groups. This has not as yet been definitely established, but the available evidence seems to justify the assumption. If this is the case, then a moulding powder, produced with coconut-shell flour as a filler, will possess appreciable quantities of reactive lignin, and in the curing of such a powder the lignin will react with the formaldehyde produced by the disassociation of the hexamine in the resin (assuming this latter to be a two-stage resin). As the hexamine is incorporated in the resin in a measured amount sufficient to react with all the free phenol present and thus complete the phenol-formaldehyde reaction. It is obvious that adjustments would have to be made with regard to hexamine content if the presence of free phenol in the finished moulding is to be avoided.

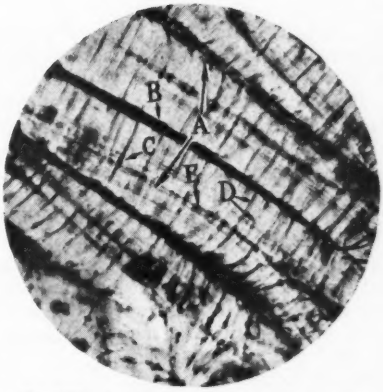


Fig. 108.—Longitudinal section of coconut shell. Mag. 445 diameters.

Therefore, in such cases where the filler contains reactive lignin in appreciable quantities, it would appear necessary to adjust the phenolic resin to suit the filler. In this way, and still assuming the correctness of the reactivity of the lignin, this latter is available for use as an extender to the resin.

Another structure appears in Fig. 107 indicating the existence of minute pits; two of these are shown at E, and appear as lines owing to the thickness of the tracheid wall. These are interesting, because where each of these appear we have a weakening of the tracheid, and, owing to the hard and somewhat brittle nature of the material, the method of break up when the shell is being ground may be expected to be affected. This will perhaps be more clearly illustrated by reference to Fig. 108, which is a photomicrograph of some of the tracheids in longitudinal section, at the same magnification as in Fig. 106. In this illustration we clearly see the great extent of the lignification of these tracheids; for example, the width of that in the centre

of the illustration is shown at A and the lumen at B. The manner in which the pits traverse the entire thickness of the wall is clearly seen.

It will be appreciated that where there are a number of these pits or ducts lying in the plane of one cross-section, a potential cleavage plane exists. We have seen from an examination of the transverse section that these ducts do radiate from the centre and more or less in one plane, therefore, when seen in the longitudinal section it becomes apparent that the lines representing the ducts in Fig. 108 also indicate the position of cleavage planes in the tracheid, thus when subjected to crushing forces, the tracheid in question may be expected to break across at points such as that shown at C, and as these planes are parallel to one another, such as those shown at D, the whole tracheid may be expected to disintegrate into a large number of thin slices, as it were, each of which would represent a transverse section of the tracheid.

One curious feature of the structure of these tracheids is worthy of mention, and that is the manner in which the pits in one tracheid continue into and through another vessel lying next to it, thus at E (Fig. 108) we see an interface where two tracheids touch one another, and it will be noticed that the pits marked D, as well as others, are continuous through the walls of both tracheids. In this manner a highly complex system of continuous ducts is developed so that the interior of each tracheid is in communication with that of those lying next to it, and, in fact, this communication exists throughout the entire structure of the shell.

However, returning to the question of the effect of structure on the manner in which the tracheids will break down under grinding, we see by Fig. 109 that the expected result is fulfilled. This illustration is a photomicrograph of some coconut-shell flour at a magnification of 70 diameters. The flour is of approximately 90 mesh, and, as will be seen, consists mainly of the cross-sectional tracheid units previously described.

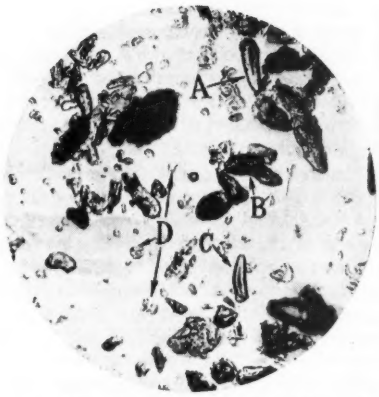


Fig. 109.—Coconut shell flour. Mag. 70 diameters.

Three of these are annotated at A, B, and C, which clearly shows them to be thin slices of tracheids; in fact, the entire powder is made up of these units, together with a percentage of dust, as shown at D, which is generated by a further breakdown of the unit particle. The existence of the dust may be explained by the fact that a large proportion of units would be obtained from large tracheids and as such would not pass a 90-mesh sieve. Upon further grinding, however, these units would be disintegrated into much smaller particles, whose sizes would be governed by the number of radial ducts existing in the unit.

The structure of this flour has a pronounced effect on the flow properties of moulding powders wherein it is used as a filler. This would appear to be due to its density and low specific volume in the powdered condition. Schueler* gives the B.S.S. flow of a moulding powder made with 50 per cent. resin, 50 per cent. coconut-shell flour as 5, whereas that for a powder made with the same proportions of resin and filler, in which the filler is wood flour, he gives as 12. This shows a considerable improvement on the wood-filled powder, but as the filler details,

* Schueler, "Coconut Products and the Plastics Industry," "Plastics," February, 1946.

such as species of wood and mesh size, are not mentioned, it is difficult to form a conclusive opinion, likewise the proportion of the improvement which is due to the presence of reactive lignin and that which is due to the morphological characteristics of the coconut-shell flour unit, is difficult, if not impossible, of assess. There does, however, appear to be no doubt that there is an improvement. This is interesting, inasmuch as where a moulding powder is made up by solution methods only, then the flow properties appear to be poor; however, work is still in progress on this subject.

With regard to impact strength, the same author shows that the coconut-shell-filled powder is superior to wood filled, that of the former being given at 0.21 ft./lb., while the latter gave 0.17 ft./lb. In view of the brittle nature of the shell and the strong tendency for the flour particles to approach a spherical shape, when compared with the fibrous nature of the wood-flour particles, this high impact strength would appear to be anomalous, but thought upon the subject will show that a possible explanation lies in the assumption of a large proportion of reactive lignin in the shell particles, which virtually become part of the resin matrix by the formation of new complexes resulting from the reactions. If this condition exists in fact, then the appearance of this unexpectedly high impact strength is explained.

On the other hand, Schueler gives the tensile strength of the shell-filled powder as 5,166 p.s.i., while that for the wood-filled powder is 8,016 p.s.i. We see from this that apparently in spite of the chemical bond between filler and resin, in the case of the shell filling, the effect of the particle shape is so great as to produce the reduced figure; however, as in the previous case, this is conjecture and there may quite possibly be other reasons underlying these two phenomena.

Taking these results as they are, we would be justified in indulging in a degree of optimism with regard to the prospects offered by coconut-shell flour, particularly so in respect of the electrical characteristics which show a considerable improvement in all the characteristics quoted by the aforementioned author. I would like to take the opportunity of acknowledging my appreciation of the help received from Mr. G. B. E. Schueler, who kindly supplied samples.

(To be continued.)

PLASTICS IN PARLIAMENT

In the House of Commons on July 10 Sir I. Fraser asked the President of the Board of Trade if he were now in a position to arrange for increased supplies of phenolic moulding powder for firms making electrical accessories.

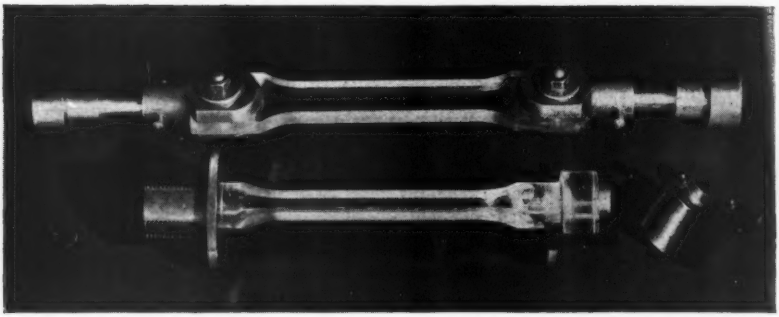
Mr. Belcher (in reply) said the supply of phenolic moulding powders was now considerably greater than before or during the war, but he was afraid that no further substantial increase could be expected until additional manufacturing capacity came into operation towards the end of the year. Meantime, the uses to which producers were giving priority in distributing these powders included the making of electrical accessories for housing.

On July 22 Mr. Gallacher asked the President of the Board of Trade if he would consider the reduction of raw material for plastic products that are only marketable because of a shortage in cotton goods. in order to increase supplies for the maintenance of the staple plastics industries.

Sir Stafford Cripps (in reply) said the plastic products which are being marketed as alternatives to certain textile goods are made from polyvinyl chloride. Discussions regarding the distribution of this material are taking place with the producers and users in the plastics industry, and steps have already been taken to ensure adequate supplies for the more important purposes.

Mr. Gallacher then asked if the President of the Board of Trade would take note of the fact that there is a plastics industry in Scotland that is threatened with closing down, and would he see to it that supplies of raw material are made available to keep this industry going?

Sir Stafford Cripps: Certainly.



Specimen holders showing methods of attaching test pieces.

Tensile Testing of Rigid Plastics

TO provide means for investigating the mechanical properties of rigid plastics and thereby give engineers more reliable data for design purposes, W. and T. Avery, Ltd., have added to their productions a testing machine specially designed for tensile testing under conditions of loading, straining and temperature which are precisely controlled.

This machine was built primarily to the order of the Plastics Division of Imperial Chemical Industries, Ltd., for research into the physical characteristics of rigid plastics. It may be used either for constant rate of loading, constant rate of straining, or creep tests; also for applying and removing the load from the specimen. Autographic recording apparatus is provided; likewise means for measuring extension. Another notable feature is the ample space provided adjacent to the specimen under test for accommodating apparatus for temperature control, such as a heating oven or a refrigeration chamber. The specimen holders are of the bayonet-joint type, well suited for the accommodation of headed specimens, and are convenient for the attachment of subsidiary adapters for different forms of the specimen. A maximum distance of 30 ins. between the holders has been provided.

The load-measuring gear is of the conventional lever and steelyard type, two ranges being provided by the use of a poise weight in two parts. The machine which is illustrated has a loading capacity of 5,000 lb., with a minor range of 1,000 lb. Sub-divisions of 0.5 lb. are obtained by means of a dial vernier on the end of the poise screw.

The straining screw derives its motion from worm gearing fitted to the machine base. An extension to the worm-shaft drives the extension measuring mechanism which records the movement of the screw in units of 0.001 in. A further shaft, fitted with a pair of pulleys, is used for the extension ordinate of the autographic recorder. The straining screw has been made of stainless steel to avoid corrosion.

To provide the necessary flexibility in speed control and also to cover the requirements for automatic control, a pair of infinitely variable gearboxes are fitted to the machine, one driving the straining gear and the other driving the loading gear. These gearboxes, which are of Avery design, provide speeds which are infinitely variable from zero upwards, and are each fitted with remotely controlled mechanism.

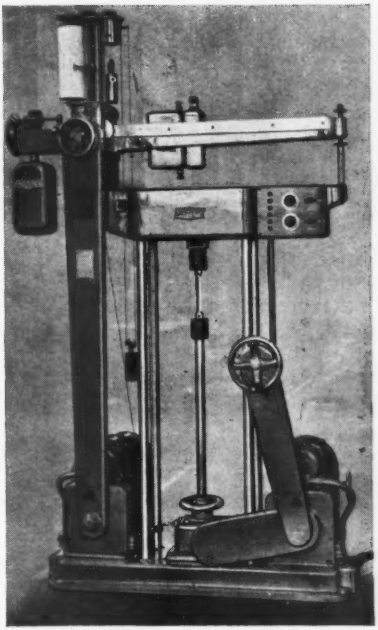
Two pulleys on the input side of the

gearbox are rotated at different speeds by the use of an adjustable-pitch diameter vee-rope pulley on the motor shaft, together with a fixed-ratio drive from the same motor. These two speeds are compounded differentially to produce a range varying from zero upwards. This output is passed to a duplex compound epicyclic train which provides a further reduction in speed, and forward-and-reverse operation, by the selection of one or other of the two trains of gears. Selections of the output shaft direction is performed by a pair of solenoid-operated rockers which lift ratchet pawls engaging the members of the epicyclic train.

The speed ranges for the machine illustrated are 0 to 1,000 lb. per minute, or 0 to 200 lb. per minute, according to the load range in use, and 0 to 0.2 ins. per minute on the straining side. The transmission from the gearboxes being by chain and sprocket gearing, these ranges can be modified readily, and a further range of 0 to 2.4 ins. per minute is available on the straining side by reversing the driving and driven sprockets.

The method used for controlling the machine for the various types of tests is another novel feature. The rise and fall of the steelyard actually operates easily adjustable contact switches controlling the current to the direction-selection solenoids.

By means of these features, continuous loading or straining in either direction may be selected. At the same time, the other gearbox comes under control of the steelyard, causing the controlled function of the machine to stop, start, or reverse, according to the rise and fall of the steelyard. Thus, when straining at constant rate, the poise will run out when the steelyard rises, stop when it is balanced, and run back when it falls. To function in this way it is obvious that the poise speed must be faster than the rate demanded by the characteristics of the specimen. The control, however, still functions with zero rate of strain (relaxation test) and with zero rate of load (creep test), and works in either direction of operation.

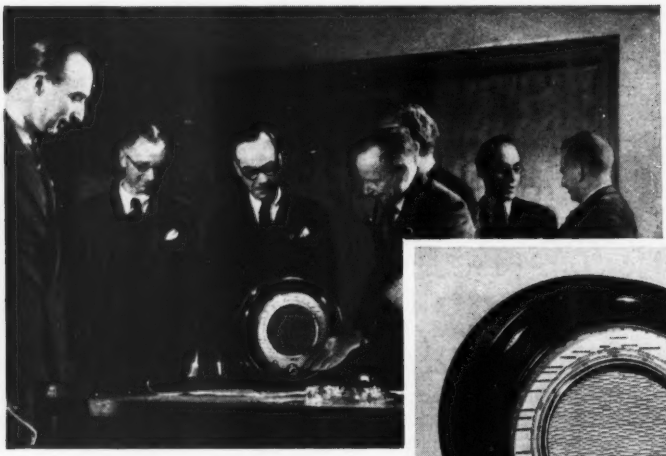


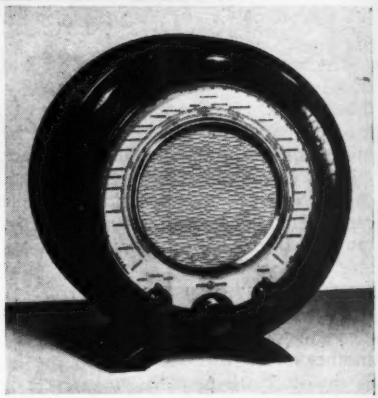
The new Avery tensile testing machine which has been specially designed for testing rigid plastics.

The control is exceedingly smooth in operation, and the control switches in no way impair the sensitivity of the steelyard mechanism. When a specimen breaks, the two motors stop automatically. Provision is made for hand straining and hand loading, independent of power control.

A drum-type autographic recorder is fitted, giving a diagram 10 ins. high and 12 ins. long. Four ratios of extension magnification are provided, namely, 1 to 1, 2 to 1, 5 to 1 and 10 to 1, transmission being obtained by means of stranded steel wire cables. A synchronous electric clock is used as a time base enabling load-time records to be made of relaxation tests, and extension time records for creep tests. The time scale is half an inch to the hour, so that the machine can be left unattended for long periods, such as overnight.

Plastics Can Make It





A NEW RADIO CABINET

THE cabinet of the first post-war radio receiver made by E. K. Cole, Ltd., is regarded as an outstanding example of industrial design. The executives of the firm were so proud of it that a film was made at the Ekco works to show the complete process of manufacture right down to the final assembly line. The preliminary development of this receiver and its translation from drawing office to workshop is also featured. The film is now being exhibited to the public, being "No. 3, Design in Industry," in the series "Britain Can Make it." Additionally, it was televised on June 28. In a convincing manner this film shows the possibilities of plastics as a medium for uniting good design and robust construction.

The accompanying photograph shows (left to right) Mr. W. M. York, publicity manager; Mr. N. C. Robertson, M.B.E., deputy managing director; Mr. E. K. Cole, managing director; Mr. A. W. Martin, M.B.E., chief engineer; Mr. Bentley Jones, assistant radio sales manager, and Mr. H. Hunt, of the development and engineering department, with the set which was spoken of as the "star" of the cast of the film. Behind Mr. Martin may be seen the head of Mr. Wells Coates, R.D.I., who also designed so many of the company's earlier models.

The Ekco A.22 is a three-valve (plus rectifier) three-waveband superhet for operation on A.C. mains of 200-250 volts. The circular plastics cabinet is finished either black and chromium or "walnut" and bronze, and is a one-piece phenol-formaldehyde moulding. The central speaker is surrounded by a Perspex tuning dial, greatly enlarged for easy and accurate visual tuning, with station names on the long and medium wavebands and transmission on the short wave indicated in three colours. The components follow the circular layout of the cabinet, allowing easy access.

SYMBOLIC PLASTICS

RELIGIOUS PENDANT

INJECTION MOULDED FROM CELLULOSE ACETATE. BACKGROUND WITH GOLD METALLIZED COATING.

RELIGIOUS WALL DECORATION

COMPRESSION MOULDED FROM UREA MOULDING POWDERS. THE CROSS TO BE INSERTED INJECTION MOULDED FROM POLYSTYRENE WITH LUMINISCENT PIGMENTS.

ORIGINAL DRAWINGS AND SPECIFICATIONS FROM THE PLASTIC RESEAI

POCKET

THE THREE BAC
FROM TINTED
SHEETING SU
SANDBLASTE
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CELLULO
PHENOLIC
THEN MO
BACKGR

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COMPRESSION M
PROOF PHENOLI
SOLID LAMINATE

THE PLASTIC RESEARCH LABORATORIES OF GEORGE B. E. SCHUELER

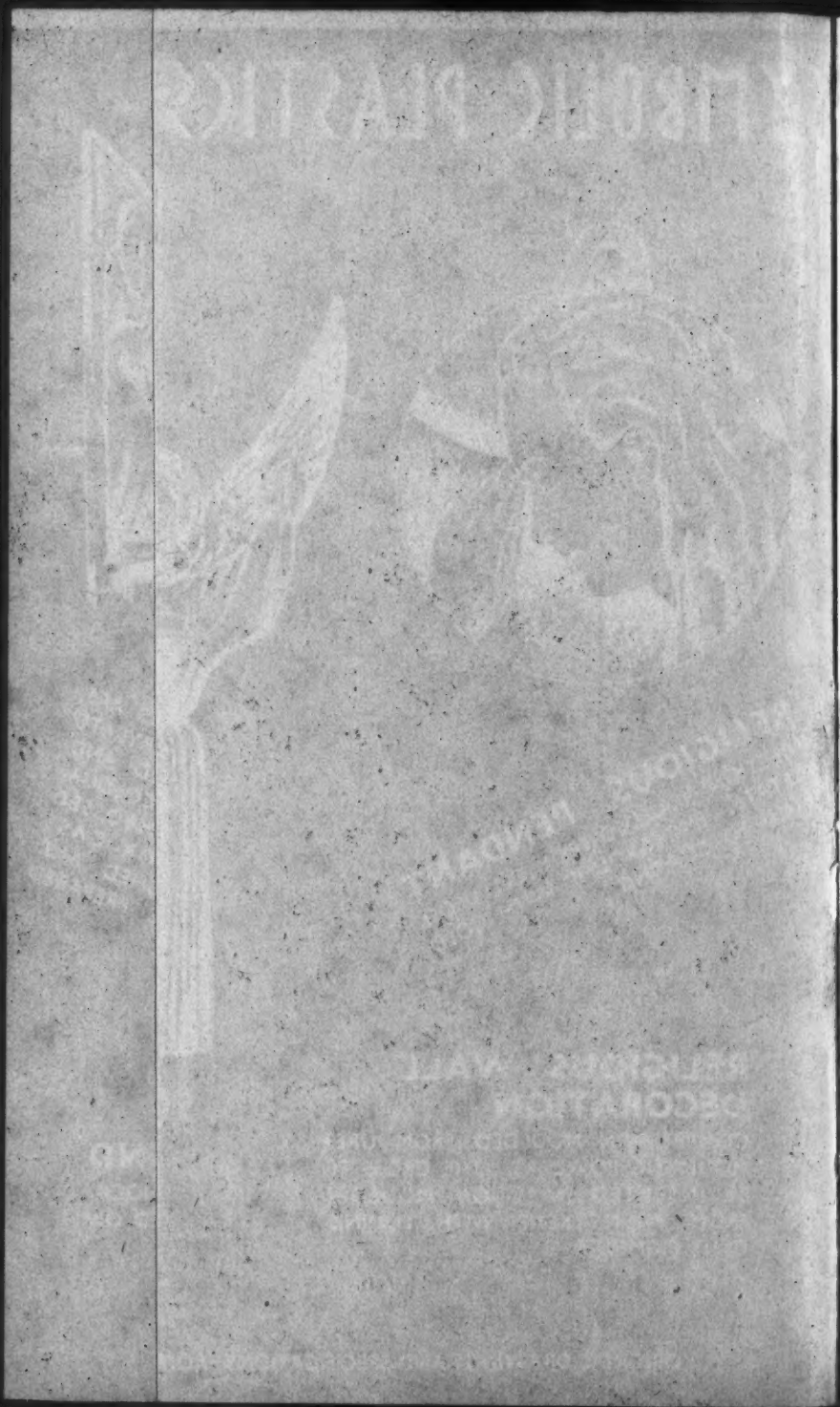
KET ALTAR

HREE BACKGROUND SHEETS ARE
M TINTED METHYL METHACRYLATE
ETING SUITABLY ENGRAVED AND
NDBLASTED. SOME OF THE COLOUR-
L FIGURES ARE OF EMBOSSED
ELLULOSE ACETATE OR CAST
HENOLICS HIGHLY POLISHED AND
THEN MOUNTED ON THE PREPARED
BACKGROUND.

Y CROSS STAND

ESSION MOULDED FROM SHOCK-
PHENOLICS AND MOUNTED ON
AMINATED SHEETING.

CHUELER, CONSULTANT.



World's Industry Employs Plastics

GENERAL ENGINEERING

Drill jigs made of Masonite have been widely used during the war years for die work, and are now extensively replacing steel and cast iron. Several examples of simple and complicated forms are given in "Machinery" (1946/**69**/41). **Protection of tipped tools** made by A. C. Wickman, Ltd., is obtained by use of plastic coatings. ("Mech. World," 1946/**119**/643.) **Reclaimable tool plastic,** Plastiform, is a combined ceramic and thermoplastic material, available through Duorite Plastic Industries; it has a compressive strength of 15,000 p.s.i., high impact resistance, excellent machineability, light weight, and complete resistance to acids and alkalies, and is ideal for boilers. ("Modern Machine Shop," 1946/**19**/174.) **Plastics moulding materials** are classified in tables published in "Machine Design" (1946/June/159); an appendix deals with properties, characteristics, applications and manufacture. **Thermoplastics** are generally reviewed in "Production Engineering and Management" (1946/June/51), drilling, sawing, filing, cutting, buffing and polishing and painting being mentioned. **Precision operations** are applied to plastics at works of Ford Motor Co. ("Materials and Methods," 1946/**23**/1638.) **Data on plastics** now available for machine and plant construction covering a wide range of application has been compiled in "Mechanical World" (1946/**119**/683). **B.C.H. bearings** manufactured by the impregnation of selected fabrics with synthetic resins, are described in "Eng. Materials" (1946/**4**/370). **Plastic-like felt mountings** capable of reducing machine vibration by more than 70 per cent. are claimed by manufacturers of a new material in the United States under the name of "Feltan." **Applications of "Perspex,"** including corrugated forms, are described in "Machinery Lloyd" (1946/**18**/52). **Problems in technology of plastics,** including heatronic moulding, low-pressure and contact pressure laminating, cellular core laminates, expanded resins, continuous contact pressure-laminating, laminated surfaced plywood, and postforming of laminates, are discussed in "Mechanical Engineering" (1946/**68**/531).

CHEMICAL

New resin, Teflon, made by DuPont by polymerizing gaseous tetrafluoro ethylene has exceptional properties of resistance to heat and to chemicals, low water absorption rate and high impact strength plus adequate toughness. ("Materials and Methods," 1946/**23**/1571.) **Pigment dispersion** in synthetic-rubber latex is studied in "Engineering Abstracts" ("Product Engineering," 1946/**17**/323), which also publishes an article on the **stability of phenolic plastics.** ("Product Engineering," 1946/**17**/320.) **Synthetic rubber production** in America during 1944, amounting to 737,000 tons of GR-S, compares well with 120,000 tons in any similar period by Germany, according to E. G. Chilton ("Mechanical Engineering," 1946/**68**/527), who there discusses technical advances made during 1945 and gives 178 references to the literature.

BUILDING

Plastic-coated wire-mesh for windows, known as Cel-O-glass, is again available. **Resin-impregnated plaster** is discussed in "Materials and Methods" (1946/**23**/1,011); preparation of this plaster, as well as its applications, are described. **"Scrubable" wallpaper,** under the name "Varlar," was shown to the public at the first post-war demonstration of machine-made papers in the United States. This paper, which is claimed to withstand "25,000 consecutive rubs on the same spot," is made by a patented thermoplastic process using synthetic resins which are fused with paper or cloth. It differs from plastic-coated papers in which the finish is merely applied to the surface of ordinary paper. **Continuous cross-laminated plywood** is now fabricated from lumber pieces. It is 12 ins. wide and can be laid in a fraction of the time required for ordinary strip-type flooring. ("Mechanical Engineering," 1946/**68**/539.)

ELECTRICAL

Plastic-impregnated glass fibres bonded under heat and pressure produce commutator-segment insulation for electric motors; in the view of some German manufacturers it is much better than mica. ("Electrical World," 1946, Feb. 2, abstracted McGraw Hill "Overseas Digest," 1946/March/16.) **Plated plastic commutators** have been developed by Metaplast Co., New York. **Silicones,** as silica-based plastics of interest to the ceramic industry, have recently been surveyed by S. L. Bass, J. F. Hyde and R. R. McGregor. These materials derive many of their most useful properties from the inorganic nature of the silicon-to-oxygen links which they have in common with glass and mineral silicates. Plasticity, solubility and water repellency are due to the organic radicals attached to their basic structures. ("Journ. American Ceramic Society," 1946/**29**/66.) **Cellulose acetate film** for use as capacitator dielectrics is improved by loading the film with ceramic powder. ("Product Engineering," 1946/June/508.) **Plastic shields** for energized power transmission line conductors of voltages up to 14,400, or beyond the range of rubber protectors, have been developed. They consist of three end-to-end tubes slotted to go over conductors of voltages up to 14,000, or small angle structures. ("Electrical World," according to McGraw Hill "Digest," 1946/May/30.)

MISCELLANEOUS

Plugs for stopping leaks in tanks, to avoid the costly shutting down of producing plant, are being made of neoprene and vinylite. ("Products Finishing," 1946/June/112.) **Quick-setting liquid plastic** developed by National Plastics Products Co., is a clear, pale and viscous mass which is poured into a mould after being mixed with an accelerator; it hardens in a short time at room temperature, giving a solid opaque casting, which gradually develops an ivory shade. ("Materials and Methods," 1946/**23**/1712.) **Germ-destroying lamps** developed for refrigerators by Sanilite Co., have plastic end fixtures made from phenolic moulding compound. ("Product Design," 1946/June/461.) **Laminated glass film** has been developed by the Profilm Corporation; it is made of from 5 to 16 layers of transparent glass, and has a size of 16 by 17 ins., and is said to be finished within 0.00005 in. ("Modern Machine Shop," 1946/**19**/304.) **Plastic seals** said to be free from scratches, free

from corrosion, and free from rust, are being marketed by Progressive Systems Inc.; one operation seals and keeps tools airtight. ("Machine Tool Blue Book," 1946/June/168.) **Transparent plastic cases** are being used for complicated scientific instruments, in particular electronic instruments, to facilitate instruction. ("Instrument Maker," 1946/May-June/24-22.) **Wood finishes** are improved by the use of melamine, vinyl, styrene or acrylic coatings. ("Mech. Eng.," 1946/**68**/425.) **Portable plastic melter,** to give plastic protective coating to plugs, gauges, tipped tools, etc., is made by Aeroil Products Co. ("Scientific American," 1946/**174**/272.) **Centrifugal casting** has made it possible to cast homogeneous, low-cost phenolic articles in lots up to 5,000 pieces; the phenolics may contain both pigments and fillers. ("Mill and Factory," 1946/June/100.) **Tennis-racket string** of twisted multifilament nylon yarn provided with a new coating is the subject of a United States patent assigned to the Du Pont Nemours Co. It is a corded affair with each strand of the cord consisting of individual filaments of polyhexamethylene adipamide twisted together. The smooth coating constitutes about 30 per cent. of the total weight. **Synthetic rubber hose,** reinforced with a fibre-glass inner braid, has been developed by De Vilbiss Co. for hot plastic paint. ("Product Engineering," 1946/**17**/283.) Peace-time uses of plastics are described in "Science Illustrated," 1946/**1**/33. **Plastic furs** are to be manufactured at Montreal, Canada, by a process in which ordinary tanned and sheared sheepskins, with wool varying from $\frac{1}{2}$ to $1\frac{3}{4}$ ins. in length, are first subjected to the action of gaseous hydrogen chloride to change the keratin molecule, which is the basic component of hair. Subsequent hydrolysis separates the molecular chains into two kinds (amino and imino), following which formaldehyde is applied to the softened hair to cause "molecular welding." Cresol is used for final treatment. **Plastic trowelling composition,** Plastipaste, which will readily adhere to wood and other surfaces not coated with a wax parting agent, has been announced by Duorite Plastic Industries. ("Scientific American," 1946/**174**/279.) Its uses include the making of relief maps and containers for corrosive chemicals. Essentially a phenolic resin, it is held to dimensional tolerances by controlling the shrinkage by regulation of the percentage of filler employed, the latter being preferably a special fibre under the name Duorite Flox Filler. When rapid hardening is desired, this can be effected without heat in 30 minutes by replacing the regular hardening catalyst with a special one. **Plastic stethoscope,** produced by Hellermann Electric, Ltd., claims that its acoustic properties enable it to be used with success for the detection of hearing noise in motors and generators. As regards medical uses, it is said that the instrument gives better results than are obtained from stethoscopes with metal ends. ("Electrician," 1946/July 19/181.) **Wire and cable insulation** obtained by use of vinyl plastics proves superior to that of natural rubber ("Rubber Age," 1946/**58**/703); the extrusion of vinyl materials is described. **Packaging applications** of non-woven textiles are made by bonding cellulose fibres with thermoplastics ("Modern Packaging," 1946/**19**/100).

SOURCES OF REFERENCE.

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

The Silicon Plastics (continued)

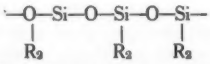
By E. E. HALLS

In this final aspect of consideration of the silicones, the contrasting composition, formation and behaviour of the silicon esters is given.

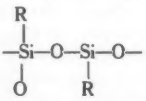
IN "Plastics," June, 1945 (p. 273), W. Penn presented a clear picture of the chemistry of the silicones, including their production and polymerization. Representing the organo grouping as R. Penn showed the following:—

(1) The silanol type R_3SiOH that is capable only of condensation to the simple ether type $R_3Si—O—SiR_3$, which is non-resinous.

(2) The silanediol type $R_2Si(OH)_2$, capable of condensation to thermoplastic derivatives, which are permanently fusible and of the following type:—



(3) The silanetriol type RSi(OH), that can condense to a three-dimensional system, which is thermosetting and of the following type:—



The simple silicon ester is of the type $Si(OR)_4$, such as pure tetra ethoxy silicane, $Si(OEt)_4$. By the presence of some water in their preparation, hydrolysis and condensation occurs, so that higher homologues are formed, such as hexaethoxy silicane, $Si—O—Si(OEt)_3$.

$$(OEt)_3$$

Twenty years or so ago, these silicon esters attracted much attention because of rapid hydrolysis in the presence of moisture, and the possibility of utilizing the residue silica with its properties of hardness and chemical inertness, refractory characteristics and excellent dielectric qualities. If the esters could be manipulated in the right manner, it signified that a medium for pigments to form paints, enamels and distempers could be developed; a vehicle for cements and a binder for refractories was envisaged; a cold or low temperature glaze for ceramics was foreseen; and materials for the electrical engineer were also possible, impregnants, fillers and film formers. Much work has been done in all these directions, and much has been achieved, although applications have been over by no means such a broad sphere as might have been anticipated. The reason for this is a little obscure, but probably lies in lack of commercial effort to exploit the materials in fields where their properties render them most advantageous. During the war, the silicon esters have been reserved for priority purposes, and have been extensively used very successfully both in America and in this country Some very fine jobs have been achieved with their aid, and as a result of the practical experience gained, as well as the fairly wide demonstration of some of their possibilities, it is felt that the future will see silicon esters establishing for themselves a regular place among the raw materials of many industries.

Commercial Applications

Normally, established commercial applications include the following:—The filling of thermometer graduations with silicon ester bound pigment; cementing of electrical heating elements, as for irons, with silicon ester bonded sillimanite; hardening of concrete floors; restoration of stonework of ancient buildings; damp-proofing and decoration of porous surfaces.

The absence of any appreciable application in the electrical industry in this list is surprising. The electrical world has major uses for surface treatments, adhesives, enamels, coil treating materials, among other things, and the

possibility of applications in that sphere is still an optimistic one.

A very interesting picture under the heading of "Silicon Esters and Their Application to the Paint Industry," by G. King, was given in "Industrial Chemist," March, 1930 (p. 112). King points out that the expression "silicon ester" includes all alkyl and aryl silicates and mixed silicates, and that the principal ones are the ethyl silicates, with the methyl, amyl and butyl silicates also of industrial consequence. The following notes are taken from this paper.

Ebelman discovered ethyl and amyl silicates in 1846. Friedel and Crafts, in 1866, studied chloro-ethyl silicates and from them produced a mixed amyl-ethyl silicate. Hofmann's suggestion in 1860 to use silicon ester for preserving stonework was a failure because Ebelman's ester only gave a granular silica having no bonding power. For the same purpose, in 1923, A. P. Laurie mixed silicon ester with a volatile solvent such as alcohol or benzene and showed that, if sandstone was moistened with this solution and then exposed to the action of moisture in the atmosphere, slow hydrolysis occurred, giving a film of hydrated silica that bonded the particles of sandstone together.

This marked the first important stage. The Ebelman tetra-ethyl silicate is insoluble in water and deposits silica only after long standing and then in the form of a granular powder. The Laurie idea of alcohol as a solvent enabled penetration into the stone to be achieved, but also gave a mutual solvent for the ester and for the water, thus enabling a film-forming hydrolysis product to be obtained.

King points out that the hydrolysis can follow any one of two courses, viz.:—

$$Si(EEt)_4 + 2H_2O = SiO_2 + Et.OH$$
$$Si(OEt)_4 + 4H_2O = Si(OH)_4 + 4Et.OH$$

But in the second of these reactions the silicic acid formed will condense to form complex silicic acid molecules, and as these exist in 12 different known forms, a control on the ratio of water to silicate present for the reaction is necessary to obtain a predetermined form of final product.

King experimented along these lines, adding water in a predetermined manner to solutions of ester in absolute alcohol or toluene. The silica produced remains in colloidal solution in the absolute alcohol. It can be coagulated by ammonia, but an important characteristic is the coagulation of this silica without addition of electrolyte or evaporation of the alcohol.

King's ester is made by the action of 1.3 to 1.5 parts by volume of alcohol on one part of silicon tetrachloride; equal volumes of the liquids are intimately mixed and then the remaining alcohol is added with stirring. The hydrochloric acid must be rapidly removed.

The paint medium differs from the stone preservative, and is produced by adding 315 litres of the ester with stirring to 50.7 litres of water previously dissolved in 135 litres of 94 per cent. alcohol. The mixture is stirred until a uniform solution is obtained, at which stage hydrolysis is proceeding rapidly. This signifies that water in the alcohol is being replaced by alcohol from the hydrolytic reaction. As this progresses, more and more ester is taken up until, finally, a uniform solution is obtained. Up to this stage, more water has been employed in the solution than is required for hydrolysis. This is corrected by adding a further 250 litres of the silicon ester, and in this way a solution is produced that has been shown to contain the best proportion of silica and silicates, and the right type of silicates, to give a paint medium suitable for porous surfaces such as those of asbestos cement sheet and concrete.

This silicon ester medium loses solvent upon exposure to air, whereby coagulation of the silicon is accelerated. Thus the liquid medium which can be kept unchanged for several months in a stoppered container, becomes insoluble in a few hours of exposure when applied to the surface to be painted, and a second application of a different colour can then be made without danger of the running

of colours. After the preliminary very rapid setting, a slow process of final hardening occurs that takes several months. This type of medium contains no salts or non-volatile compounds unless added for specific purposes. It has low conductivity, surfaces painted with it do not effloresce as a result of changes taking place in the silicate. It can be applied to alkaline surfaces, such as those containing slaked lime, and it is not affected by dilute caustic soda or weak acids other than fluoric acid. The surface film is silica, and therefore hard, so that brushing or the use of soft soap and soap powders can be exercised without harm. With the choice of suitable pigments, a temperature of 500 degrees C. can be withstood without deterioration.

Regarding pigments, King states that zinc oxide and the basic colours are not suitable as they affect the stability of the solution, and that carbon blacks are also unsatisfactory. Satisfactory ones quoted for exterior work are:—Titanium white, black oxide of iron, chrome green, golden ochre, vermilion, monolite red and yellow, ultramarine, raw sienna, burnt amber, venetian red, bright red oxide of iron. He indicates that troubles normally encountered on cement and porous surfaces containing lime are overcome by using silicon ester paints. Their ease of working and coverage offset their additional cost, and they yield a more lasting coating.

With few exceptions, powdered pigments mix readily with silicon ester medium, and, although particle size is important, it is not so critical as with oil paints. Imitation stone paints can be made by incorporating stone oolites. An ideal white pigment is titanium oxide; further, the pure pigment is not essential, the inorganic lake pigments on a base of barium sulphate being quite satisfactory.

The silicon ester paints are porous and can be safely used on brick and stone where it is essential for the surface to breathe. For the same reason, it is evident that a single coat is insufficient for the preservation of wood or corrosion resistance of metals. On the other hand, for coating surfaces for use at elevated temperatures, such as exhaust manifolds, the silicon ester paints have been employed successfully.

There is a limit to the keeping properties of silicon ester paints of this type; they should be used within a month of manufacture. Aqueous solvents will change the character of the paint. Gelled material cannot be corrected, but brushes, etc., can be cleaned in methylated spirit.

These silicon ester types of paint yield a matt or eggshell type of finish, hard, scratchable by fluorite, but not by calcite. For porous surfaces, the silicon ester medium should be one rich in silica in order to fill and permit a film to form on the surface. For less-porous surfaces, a more dilute medium can be employed. For plaster, although silicon ester is the most perfect medium, it is not foolproof, because, obviously, not only does one plaster differ from another, but, further, the same plaster varies over itself. It is therefore preferable to treat plaster with the stone preservative type of medium first, and then a silicon ester paint containing less silica than is necessary for concrete can be utilized.

Using these silicon ester media, no special technique has to be developed. It is simple to mix the dry pigments with the medium as required. This is satisfactory for brushing. For spraying, the grinding of the pigment with a non-aqueous solvent, such as cyclohexanol or xylene, is advocated, and then this paste can be mixed with the medium immediately prior to use.

Clifford Shaw and J. E. Hackford, in "Industrial Chemist," March, 1945 (p. 130), briefly bring the position on the silicic esters to date in an article entitled "Developments in the Application of Silicic Esters." They indicate that these materials had important war usages, and the demand probably restricted the development of wider fields of exploitation. Established uses were widely extended with success during the first years of the war. Damp-proofing of brickwork which often consisted through force of necessity in a single brick con-

struction without cavity, represented a major application, and the camouflaging of concrete surfaces, particularly when resistance to abrasion was a necessity, was another. New developments centred around the refractory properties of the materials, and Shaw and Clifford note with surprise the lack of development on the electrical side. Difficulties arose periodically from the unstable nature of the product before coagulation and sometimes due to inconsistencies in its behaviour. The urgent conditions, controlled distribution and the nature of the applications concerned, limited these shortcomings to inconveniences and prevented them amounting to major objections. In the normal course of events, fuller research and development may have been necessitated.

The following abstracts the main features from Shaw and Hackford's paper, the subject being one upon which they are experts.

The early problems encountered by progressive experimenters are summarized. Variations in viscosity and other differences occurring over a short period of time, quite distinct from the more obvious change from liquid to solid; disappointments in the expectation of clear, varnish-like films; the porosity of filler-laden films; the restrictions of silicon ester painted metal work to dry situations: these were positive points needing explanation or research to overcome.

The review of applications by King (21) and Graulich (19), and the bibliography by Ellis (20) are quoted. Likewise King's own fundamental work (21).

Two commercial varieties of silicon ester available here, one made in this country and one in America, are discussed, and their differences explained.

The American silicon ester is made from silicon tetrachloride and virtually absolute alcohol (99 per cent. plus), and this yields almost pure tetra ethoxy silicane, Si $(OEt)_4$. In this country, industrial alcohol of specific gravity 0.822 is used. As a result, the product not only contains tetra ethoxy silicane, but also a substantial amount of hexa-ethoxy-silicane, $(Eto)_3$. Si-O-Si $(OEt)_3$, and some higher homologues plus some ethyl alcohol. This raises the silica content to about 40 per cent., as compared with 28 per cent. for the American material.

Mechanism of Hydrolysis

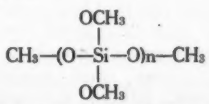
Regarding the mechanism of the hydrolysis of the silicon esters, Post's monograph (22) is referred to and only a brief survey given.

Ebelman (23) reported a slow reaction with water, and the consequent liberation of ethyl alcohol and the deposition of gelatinous silicic acid. It is stated that, in general, silico ortho esters undergo hydrolysis reactions that are quite distinct from those of their carbon homologues in that the silicon esters are much more sensitive to alkalis.

King used viscosity measurements, and the rate of change of this value to follow the progress of hydrolysis. He found, for example, that there was no tendency to gel when a mixture of tetra-ethoxy-silicane and water were allowed to react in the proportion of 1 H_2O to 2 (OEt) groups, whereas, using equimolecular solutions, the whole set in 160 days. Similar results were obtained using tetra-methoxy silicane.

Dearing and Reid (24) prepared anhydrous gels from the ortho esters by hydrolysis with an excess of glacial acetic acid. The excess of acid was removed by means of benzene and the gels vacuum dried for three weeks. The gels were found to catalyse vapour phase esterification more actively than those prepared by normal methods.

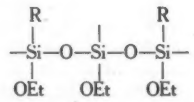
Konrad, Bachle and Signer (25) hydrolysed tetra-methoxy silicane with one molecule of water, and isolated a complex series of esters having the following type of structure in which " n " may vary from 2 to 10:—



Using approximately half molar quantities of water, hydrolysis gave mainly

hexa - methyoxy - siloxane, $(MeO)_3$-Si-O-Si $(OMe)_3$, together with methyl alcohol, there being no free water in the system. The possibility of cyclic formulæ for the esters was not excluded.

Some confirmation was given by Adrianov (26) who hydrolysed the ethyl- and butyl-tri-ethoxy silicanes, Et-Si$(OEt)_3$ and Bu-Si $(OEt)_3$, and found the hydrolysis product to be a long chain polymer. This is represented by the following type in which R may be the ethyl or the butyl radicle:—



It follows that the British ester cannot be pure tetra-ethoxy silicane as it was prepared from alcohol containing water. The work of Konrad, Bachle and Signer shows that part of the tetra-ethoxy silicane is hydrolyzed by the water present in the alcohol to give tri-ethoxy silicanol $(EtO)_3$-Si-OH. This reacts to give more hexa-ethoxy siloxane, $(EtO)_3$Si-O-Si $(OEt)_3$ and liberating alcohol. The extent of this further action is dependent upon the amount of water present and is shown by the quantity of alcohol produced. Thus the English ester contains no free water and is equivalent to a partially hydrolyzed, polymerized American ester. While the same series of polymeric silicon esters may ultimately be produced from the English or the American ester, the hydrolysis technique differs and the higher silica content of the partially hydrolized English product generally renders it more convenient.

These views have been qualitatively confirmed from experiment on the hydrolysis of pure tetra-ethoxy silicane with quantities of water up to one molecule. It has been shown that higher ethyl esters are present since the viscosity of the system increased and eventually a gel was produced. Using small quantities of water, it was possible to isolate unchanged tetra-ethoxy silicane and leave a viscous residue of higher esters.

Viscous Higher Esters

Shaw and Hackford consider that these viscous higher esters correspond to the "colloidal silica in alcohol" of King, because they can be isolated as viscous liquids free from alcohol, and are soluble in certain organic solvents (cf. Schumb and Holloway, 27). Also they are formed under the conditions described by King. Therefore his hypothesis of the colloidal nature of some hydro-esters is deemed incorrect. He reported a particle size of 3 to 5 $\mu\mu$, which is smaller than is usual for a colloidal particle and of the order required for a large molecule. Again, there is no reason to suppose that the hydrolysis of ethyl ortho silicate proceeds differently from that for the methyl ester. Konrad and co-workers found that hydrolyzing the latter gave esters having a molecular weight of the order of 10,000, and therefore the presence of molecules of similar magnitude can be expected from the hydrolysis of the ethyl esters. These large molecules can lie within King's range of 3 to 5 $\mu\mu$, and King's product could conceivably be a polymeric ethyl silicate molecule and not a particle of silica.

The solutions used industrially are prepared by the further hydrolysis of the silicon esters, and this must be controlled to yield a consistent product. The following factors require careful supervision, and this is stressed by Shaw and Hackford:—

1. Temperature rises.
2. Time period of reactions.
3. pH value during the reaction.

The products are required to condense either with or without an accelerating agent to form a gel or body with film-forming ability. These gels or films are decomposition products of the hydro-esters formed by condensation of one or more constituents of the hydroester with simultaneous liberation of alcohol.

Spontaneous Condensation

Reactions occurring in an apparently stable ester in a stoppered container after a lapse of a month or two have not been explained. The presence of traces of

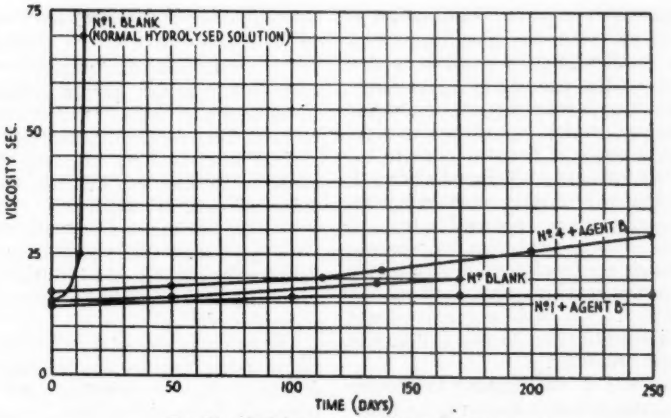


Fig. 31.—Stabilization of Silicon Esters.

hydrochloric acid due to method of manufacture, this acting as an accelerator, is one possibility suggested by the authors. They rule out the suggestion of colloidal coagulation on account of the fact that neutral electrolytes do not form a gel. They conclude that a primary cause is necessary to initiate gelling, and this may be traces of impurity (titanium being one often associated with silicon tetrachloride), a function of temperature, or due to extraneous moisture.

This spontaneous condensation is the more intriguing because no signs of change in physical or chemical properties of the hydroester may be observable for several months, then a rapid increase in viscosity is apparent until gelling occurs. The commercial hydroesters contain free alcohol; the gel initially is homogeneous, but later some shrinkage occurs with the separation of alcohol containing only traces of water.

Shaw and Hackford have also started an investigation into the mechanism of hydroesters and the gelling of silicon esters in order to throw some light on some of the anomalous phenomenon such as the following:—

(a) Some hydroesters readily incinerate to give a white ash, whereas some gels yield black ashes that are very difficult to burn white.

(b) Different percentages of gel can be obtained from the same ester.

(c) Some of the silica ashes are highly hygroscopic.

Attempts were made to inhibit or control the gelling by the addition of traces of stabilizing agents, but the indications are that the latter do not act as simple inhibitors but rather as removers of the "detonator" which initiates the gelling. This is illustrated by the curves reproduced in Fig. 31. These plot viscosity values against time for hydroesters with and without addition agents. For example, No. 1 blank represents the normal hydrolyzed solution gelling in less than 15 days, and No. 1 plus agent B still showing no hydrolysis and practically unchanged in 250 days.

Influence of Solvents on Gels

A note is made that various solvents have their own influence upon the gels and films formed from them. Toluene with some hydroesters yields a continuous transparent film. Ethyl acetate does the same under some conditions, but it more usually gives an opaque film having a rippled surface. It is, however, continuous and unbroken, and can be boiled in water or baked at fairly high temperature without rupture.

Further research by these workers has

been towards the practical utilization of some of the facts emerging from work on the mechanism of condensation and gelation. The practice is to accelerate the gel formation by the use of alkaline accelerators, which speed the process through a series of condensations to the ultimate formation of hydrated silica. It was found, with certain addition agents, that condensation apparently took a different course, producing non-porous films which possessed considerable tensile strength and stability, and, further, this type of hydrolysis could proceed without that careful attention to detail that was otherwise necessary.

In this way it was possible to use the English ester, which is known to be stable although partially hydrolized, dilute as desired with suitable solvent, and use this solution as the commercial article, leaving the user to complete the hydrolysis according to his needs. For example, in films, the ester can take in moisture from the atmosphere or by exposure to artificial humidity. Used as a binder or in a cement, the moisture can be provided by moistening the aggregate to be bound before mixing it with the ester solution. However, whatever the hydrolysis procedure, prolonged heating at high temperature ultimately yields silica as the common end point, and this silica is porous.

A direction in which these silica esters have proved invaluable during the war years, this in spite of the incompleteness of researches, and in which serious attention is being given to their exploitation for the future, is for the bonding of foundry aggregates. The ester solution supplied in the stable condition as noted above is mixed with the aggregate such as sillimanite, moulded around the job or over a plaster cast, allowed to set, and finally baked for a short period at about 1,000 degrees C. Accuracy of dimensions with no shrinkage complications during the baking or in use are advantages claimed. The specific directions in which application extends in this field are obviously dependent upon future developments as well as by the economics of the proposition.

Liquid Silicyl Esters

A recent British patent appertaining to liquid silicyl esters, 575,752/1946, due to J. E. Hackford, C. Shaw, and W. E. Smith, is of interest not only for the progress it denotes, but also for the technical data is contains. The latter shows the intricacies concerned with the stability of these esters and throws some light on the manner in which this can be controlled. The following summary is deemed useful.

The patent relates to liquids comprising silicyl esters for use as coating compositions (for fireproofing and other purposes) and as moulding materials. The term silicyl ester is intended to embrace alkoxy, aryloxy and aralkoxy silicanes. These compounds, treated with water, are hydrolized, and dependent upon the amount of water employed, one or more of the ester groups are converted to hydroxyl groups, and the corresponding alcohol or phenol is liberated. With tetra alkoxy silicanes, and sufficient water, the ester is completely hydrolyzed to the alcohol and silicic acid, with the ultimate formation of hydrated silica. The reaction is accelerated by the presence of mineral acids.

With 1½ mols. of water for each mol. of ester, gelling and film formation occur, with or without accelerators. Such liquids are very unstable, forming gels during storage more or less rapidly dependent upon the hydroxyl content, so that they are of limited practical value and become useless as coating compositions.

With less water than 1½ mols., e.g., with 1 mol. of water per mol. of silicyl ester, stability can be maintained and storage is safe for a long time without gelling, yet the mixture is still useless as a coating composition because it will not form films.

Production of a Stable Liquid

The patent is an invention to overcome these shortcomings. It is based on the addition of a small proportion of piperi-

dine to a silicyl ester to which not more than 1½ mols. of water has been added. The resultant liquid is claimed to be stable in storage and to be film forming. Moreover, upon the addition of further water, gelling occurs in a time period which is proportional to the amount of piperidine present. The invention thus covers the production of a stable liquid which, by the addition of water only, can be caused to gel within a controlled period of time, thus enabling the water mixture to be manipulated before gelation occurs. It is suggested that this result is due to the formation of primary condensation and polymerization products which remain in stable despersion in the alcohol that is liberated, and that the piperidine promotes this desirable reaction. This is in contrast with the action of mineral acids, which promote hydrolysis to silicic acid and the precipitation of hydrated silica. The possible course of the reaction with 1 to 1½ mols. of water per mol. of ester is given as under:—

$$Si(OR)_4 + H_2O = Si(OR)_3.OH + ROH$$
$$Si(OR)_3.OH \rightarrow (OR)_3\text{-}O - Si(OR)_3.$$

Whatever the theory may be, the authors have found that silicyl esters containing a small proportion of piperidine, and not more than about 5 per cent., yield film-forming, thermo-hardening compositions when water is added within the quantity limits of 1 to 1½ mols. per mol. of ester as described above. Further, this water may be added before or after the addition of piperidine, or, again, it may be present in the alcohol or phenol employed in the preparation of the ester.

Thus a pure silicyl ester may be produced, the piperidine added, and the consumer left to add the whole of the water that is required for the partial hydrolysis. A less expensive procedure is to use a hydrated alcohol for making the ester, which will then contain some water, and in this case leave the user to add only the balance of the water to complete the desired proportion. Morpholine is claimed to behave in a manner exactly similar to that exhibited by piperidine. No other cyclic nitrogen compounds of similar constitution have yet been found to possess the same properties.

Regarding the amount of piperidine or morpholine to be added, this is to some extent dependent upon the desired rapidity of ultimate gelation after the object is coated. It is said that a quantity within the range of 1 per cent. to 5 per cent. is suitable for most purposes. Less than 1 per cent. is generally too feeble. More than 5 per cent. is so rapid that generally there is insufficient time in which to carry out the operations involved in coating, etc. The optimum value of 2 per cent. has been found to be especially suitable.

Among the uses of this patented composition are waterproof coatings, fireproof coatings, and as a binder. In the latter application, dilution to a greater extent than the 1½ to 1 mol. ratio is practicable, or the filler itself may be damped or wetted.

Production of Silicones

It has been stressed that, although the chemical reactions involved in the manufacture of silicones are simple in nature, the processing technique entailed is a highly skilled one, and the degree of control that has to be exercised is very close. While little or no detailed technical information has been made available on these aspects, some insight into the difficulties encountered are given in B.P. 574,003/1945. This is due to the British Thomson-Houston Co. It concerns the final hydrolysis of the alkyl and/or aryl silicon halides and reveals the difficulties in controlling this as a single-stage reaction. Due to the heat of hydrolysis and to the presence of the halogen acid produced, there is a tendency for rapid polymerization to a hard, infusible, insoluble thermo-set solid resin of little or no value. By passing through an intermediate stage of substituting the halogen in the silicon compound by an alkoxy group, means of hydrolyzing this compound under controlled conditions to give a thermosetting silicone in the polymerizable condition

are claimed. The following explanations from the patent are of interest:—

The invention covered consists in a method of producing a mixture of alkyl and/or aryl liquid silicones, which can be later polymerized to a resin-like material, from a mixture of the alkyl and/or aryl silicon halides, first reacting them with a monohydric alcohol, and then hydrolyzing the alkoxy or arylalkoxy compounds so formed into the liquid silicones desired.

If the organo-silicone halides, especially the alkyl and/or aryl silicon chlorides or bromides, are hydrolyzed, with the object of giving resinous products that can be subsequently polymerized or condensed, and if this hydrolysis is carried out by pouring the organo-silicon halides into water, the reaction is very violent. The resultant silicone compound tends to be produced in the form of an insoluble and infusible solid or gel, which of course is useless in the sense of the usual applications for such resins. The reason is that the heat of hydrolysis causes condensation of the silicones to the infusible form, and this condensation is further hastened by the presence of the halogen acid produced by the hydrolysis reaction, this acid being an accelerator to polymerization.

This tendency to polymerize can be reduced by dissolving the organo-silicon halide in an appropriate solvent, such as ether, and pouring the solution slowly on to crushed ice. By this procedure, it is possible to obtain the organo-silicon hydrolysis products as an oil which can later be polymerized by thermal treatment. This careful method of operating still has disadvantages. Thus, a certain amount of infusible solid is liable to be formed in spite of all precautions taken. This lowers the yield of useful product. Further, the presence of the whole of the halogen acid in contact with the polymerizable product is objectionable because it causes the latter to be unstable.

Obtaining Improved Yields

The patent points out that a prior suggestion proposes the manufacture of esters from silicic acid by interacting silicon tetrachloride and alcohols in the presence of inert diluents to avoid the necessity for dehydrating the alcohols. Thus silicon tetrachloride has been interacted with ethyl, methyl and benzyl alcohols in the presence of benzene, the excess of silicon tetrachloride together with the benzene being removed on a water bath, or by distillation.

Adopting this principle, the patentees have found that improved yields of liquid silicons are obtainable from the organo-silicon halides by going via the alkoxy compounds instead of by direct hydrolysis of the halides.

The invention, therefore, first reacts the organo-silicon halide with monohydric alcohol. Thereby, halogen atoms become replaced by alkoxy or arylalkoxy groups, and halogen hydracid is eliminated. The constituents of the mixture of organo-silicon halides are of the form:—

$$R_n Si (X)_{4-n}$$

in which R represents a monovalent hydrocarbon group, X is a halogen, especially chlorine or bromine, and n is 1, 2 or 3. The monohydric alcohol can be represented by R^1OH in which R^1 is a monovalent alkyl or arylalkyl group. R and R^1 may be the same or different groups. The reaction is represented by the following general equation:—

$$R_n Si (X)_{4-n} + (4-n) R^1OH = R_n Si (OR^1)_{4-n} + (4-n)HX$$

The halogen hydracid produced is largely evolved as gas. The amount evolved can be increased and the reaction taken nearer to completion by boiling the reaction mixture under a water-cooled reflux condenser. The remaining acid may be removed or further reduced by neutralizing or partly neutralizing as with solid calcium carbonate.

The next stage is to hydrolyze the mixture of alkoxy or arylalkoxy silicon compounds, or a solution of it in any excess of the alcohol that may be present. This is achieved by refluxing with an excess

of water. The following represents the reaction:—

$$R_n\ Si(OR^1)_{4-n} + (4-n)\ H_2O = R_n\ Si(OH)_{4-n} + (4-n)\ R^1OH$$

Thus the silicols are produced under conditions of neutrality, or with an insufficiency of halogen hydracid to cause polymerization to progress to the solid resin stage at room temperature. Actually the silicols tend to intercondense to some extent as soon as they are formed, and it is for this reason that the patentees prefer to refer to the liquid hydrolysis product as liquid silicone.

If the alcohol employed is only partially miscible with water, e.g., n-butyl alcohol, the liquid silicones are obtained in solution in the alcohol, while the bulk of the water forms a separate aqueous layer. The alcohol solution can be separated, and this solution may be used as such or again the alcohol can be distilled from it.

A preference is stated for n-butyl alcohol as the monohydric alcohol, as it is more convenient to handle the liquid silicones in the form of a solution, and this alcohol is a technical grade readily available in commerce. Also, it is found that during the hydrolysis under reflux, sufficient of the halogen hydracids remain in the solution to catalyze the hydrolysis of the butoxy silicon compounds to silicols, yet not enough is retained to cause these silicols to become condensed to the objectionable solid stage at room temperatures. The following particular example is given:—

Stage 1: To prepare the silanes, 181 parts by weight of butyl alcohol are added to 139 parts of weight of a mixture of methyl silicon chlorides. This last mixture is substantially a mixture of dimethyl silicon dichloride and methyl silicon trichloride, containing 63.6 per cent. of chlorine.

The evolution of hydrogen chloride is allowed practically to cease, and then the reaction mixture is boiled under a water-cooled reflux condenser for an hour and a half. The resultant product is butoxy methyl silane.

Stage 2: 325 parts by weight of water are added and the mixture boiled under reflux for three hours. The mixture is cooled and separates into two layers. The lower one is the aqueous layer, and the upper one is a solution of the methyl silicols in n-butyl alcohol.

This upper layer, when separated, was used as a coating composition, and the coated articles baked for 3 hrs. at 190 degrees C. The coating obtained was a fairly flexible insulating film that withstood a temperature of 200 degrees C.

These notes from the patent give a small insight into the problems involved. Final homogeneity of the product involves complete elimination of moisture; maximum electrical quality demands complete freeing from halogen hydracids; the complicated mixtures of silicon halides, alcohols, water, halogen acids undoubtedly create tricky chemical engineering problems.

Conclusions

Reviewing the position on the silicon esters, it can be said that despite specific and successful applications over 20 years or so, research on the mechanism of their hydrolysis is far from complete, and much remains to be done on the properties of esters other than the ethyl and methyl products. The electrical industry should be able to look to this product for the basis of simply formulated paints and enamels of a heat resistance nature with assured electrical properties. These particularly apply to the finishing of cement/asbestos compound sheets, panels, etc., for ceramic components, and where porcelain-like coatings are required on metal work. A useful field is that of cements and adhesives, particularly for ceramic junctions.

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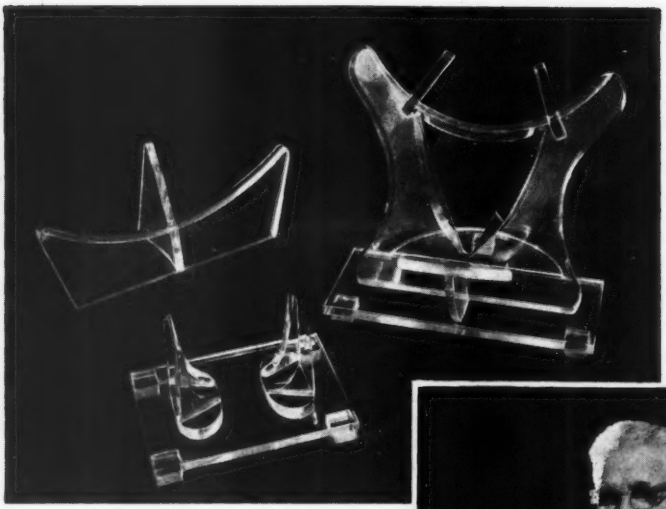
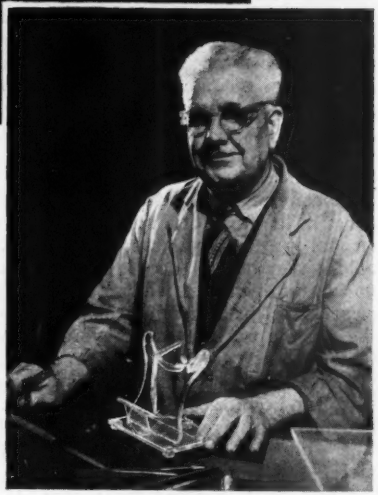




Plastics in Museum Use

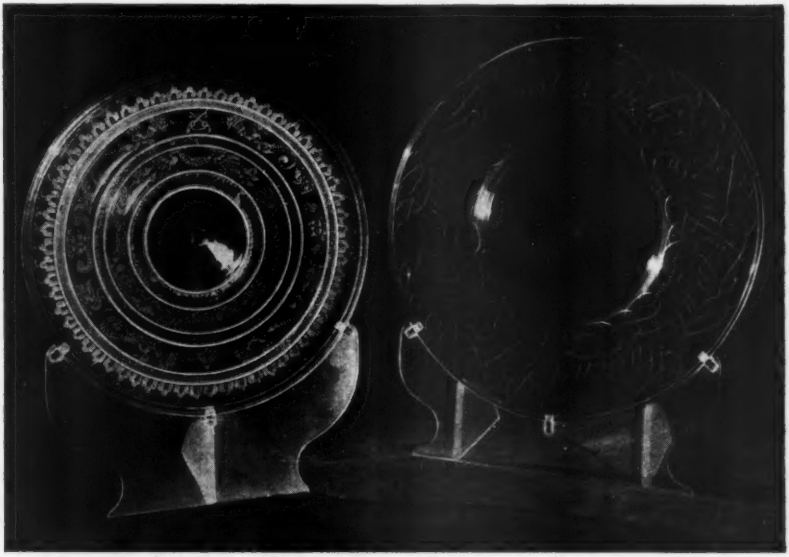
EFFECTIVE yet unobtrusive display of exhibits has for long been the aim at the British Museum. For many years use was made of wire, wood and glass, but experience showed that these materials were often difficult to adapt for a collection of relatively small objects where it is desired to show salient points of interest to the greatest advantage. From this viewpoint, each individual exhibit required a stand of its own which would do nothing to detract attention.

Just before the outbreak of war the British Museum realized that the transparency, toughness, workability and extreme lightness of "Perspex" made it a promising material for display stands. Small quantities of "Perspex" were purchased and experiments were carried out by Mr. H. V. Battern, one of the craftsmen at the Museum with more than 45 years' service.

During the war Mr. Battern served in the R.A.F. On his return to civilian life, interest in the use of "Perspex" for display stands was revived, especially for the ceramic exhibits. Many of these new stands are now serving their intended purpose in the Museum, part of which is again open to the public.

These "Perspex" stands have all been fabricated from sheet, using the facilities of the museum workshop, which is equipped with machines suitable for the cutting and polishing of plastics. The joints have been cemented with chloroform. The accompanying photographs are reproduced by courtesy of the British Museum and I.C.I., Ltd.

"Perspex" display stands specially designed to support four examples of Sèvres ware. The actual supports are shown separately in the illustration on the opposite page. Attention is drawn to the ingenious locking device for the cup.



Two engraved glasses of Dutch and Venetian origin exhibited on "Perspex" stands. It will be noticed that the stands are simple in design, and do not detract from the beauty of the glassware.

Vinidur Pipelines and their Installation

By A. HENNING

Translated from "Kunststoffe" by G. HAIM and H. P. ZADE

Pipes made from polyvinyl chloride have been used extensively on account of their excellent resistance to chemical attack. Experience gained so far has been laid down in V.D.I. Standard 2010[1], where the manufacture of pipelines made from polyvinyl chloride is covered. In addition, extensive experiments have been carried out which are not mentioned in the standard. This article, an abridged translation from "Kunststoffe," 1944, vol. 34, pp. 161-168, deals with the results of these experiments, and gives practical examples which should be valuable for the proper fabrication and installation of Vinidur pipelines.[2]

VINIDUR pipes have excellent resistance against chemical attack and good mechanical properties; in addition, they can be worked with ease.[3] Consequently, they are particularly suitable for use in the chemical industry and may also be employed successfully in the food industry as they do not affect the taste or smell of the products conveyed.

A particular requisite for the success of such pipelines is correct fabrication technique. Plumbers have to be trained for this job and should acquire a knowledge of the various fabrication methods.

Several standards have already been issued for seamless Vinidur pipes.[4] At the present time pipes for pressures at 1.5, 3.5 and 7 atm. are available. Wall thicknesses are such that the pipes withstand specified pressures up to a temperature of 40 degrees C. safely. For short time tests higher pressures up to twice the nominal pressure can be applied without detriment.

Table I and Fig. 1 correlate the permissible internal pressures with temperature. When carrying out short time bursting tests (3 mins. duration) bursting takes place only after a multiple of the pressure specified for continuous use has been reached. (For instance, a pipe 26 by 3 mm. which can sustain a continuous pressure of 3.5 atm. at 40 degrees C., when subjected to the 3-min. test at 20 degrees C. burst between 126 and 151 atm.). This property, however, should not be an incentive to stress pipes continuously at pressures higher than those corresponding to Table I.

The largest pipe of the 7 atm. series measures 75 by 8 mm.; the largest seamless pipe for 3.5 atm. 160 by 8.5 mm.; and 160 by 5 mm. for the 1.5 atm. series. Pipes of larger diameter are fabricated from foils or sheets.

MACHINING.—Vinidur may be machined by any of the known methods, but the notch sensitivity of the material should be taken into account. Even small notches should be carefully avoided, since they give rise to fractures under continuous stress. Thread cutting of pipes should therefore be avoided. Marking off should be carried out with chalk or pencils instead of scribers or other pointed tools.

Table 1.—Highest permissible internal pressure for continuous use of Vinidur pipes: Standard series

Wall temp. °C.	Fatigue strength kg./mm.²	Permissible internal pressures		
		1.5 atm. series	3.5 atm. series	7 atm. series
0	2.6	2	6.5	13
20	1.9	1.9	5.5	11
40	1.1	1.5	3.5	7
60	0.4	1.2	2	3.5

(1) V.D.I. Standard 2010, "Manufacture and Working of Plastic Pipelines made from P.V.C. (Tubular Type)." A large number of illustrations have been taken from this Standard.

(2) P.V.C. pipes made from Igelite P.C.U. (trade name "Vinidur").

(3) W. Buchmann, "Strength and Permissible Stresses of P.V.C., Z. V.D.I.," 84/425 (1940). Also "Kunststoffe im technischen Korrosionschutz. Handbuch für Vinidur und Oppanol," by W. Krannich (J. F. Lehmanns, München-Berlin, 1943).

(4) DIN. 8061, 8062, 8063, 8064, 8065, 8066, 8067.

For the machining of Vinidur pipes, tools and machine tools of the wood-working and metal-working industries can be employed.[5] Special tools are already obtainable or else in the course of development. High cutting speed and low rate of feed are required for turning. The cutting speed for sawing is limited by the amount of softening due to frictional heat. Sawing at very high speed and simultaneous high feed rate results in welding of the pipe ends following the saw cut. (In this case the teeth should be set to approximately twice the thickness of the saw and the rate of feed should be reduced.) Cutting of pipes can be done either by hand or by automatic saws. In order to obtain clean cuts automatic cutting devices or offset saws are preferable. Emery paper, rasps, files and automatic grinders or linnishers are used for de-burring, bevelling and the like.

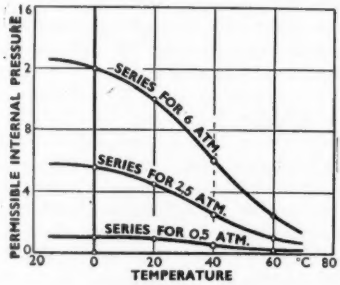


Fig. 1.—Permissible continuous internal pressures of three standard series as function of temperature.

HOT FORMING.—Vinidur pipes can be formed easily, due to their thermoplastic nature.[5, 6] The most suitable forming temperature is 130 degrees C.

Heating of the entire pipe or of the part to be formed is carried out in a special oven or in a hot oil bath. In cases where only local preheating is required a hot air blast or a soft coal gas flame may be used. Care should be taken to preheat thoroughly and uniformly and to avoid prolonged heating. Pipes should not be left for hours in the oven prior to forming, as the material will deteriorate. Forming should follow the heating process quickly. Preheating with an open flame often results in irregular temperature distribution and parts of the pipe may still be cold whilst others are already overheated or burnt. This may result in internal stresses and sometimes even in decomposition of the material. The flame should therefore not be brought into contact with the workpiece and should be moved backwards and forwards while the pipe is rotated. Overheated parts can be recognized by a darkening in colour or slight formation of bubbles and should be removed by cutting as the chemical resistance and mechanical properties no longer correspond to those of the original material.

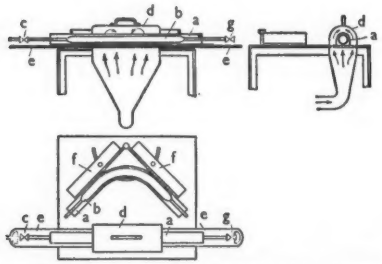
BENDING OF PIPES.—Pipes up to 10 mm. internal diameter can be bent without filling. Expert plumbers may be successful even up to 20 mm. internal diameter. In the case of larger-diameter pipes some kind of internal packing is required to avoid a reduction in cross-section. Springs are sometimes used for this purpose, but can only be applied successfully to thin-walled pipes of small diameters.

In general, filling with sand or inserting pressure tubing is the safer method. Filling with sand is carried out in the same way as for metal pipes. The sand should be dry and of uniform grain size (up to 2 mm. fineness). Tapping of the pipe walls with wooden or rubber mallets and subsequent refilling results in uniform filling of the pipe. Both ends of the pipe are then closed by stoppers. Preheating of the sand is desirable, otherwise it has to be heated with the pipe, which prolongs the preheating operation. Care should be taken that the outside of the heated pipe does not come into contact with sand, as the individual grains will leave impressions on the pipe, not only spoiling the appearance but also reducing the

(5) V.D.I. 2008.

(6) W. Buchmann, "Hot Working Properties of Igelite P.C.U.," Kunst. 32/337 (1942). Also by same author, "Rules for the Hot Forming of P.V.C.," Kunst. 33/132 (1943).

mechanical strength. When removing the sand the formation of dust should be avoided, and it is recommended to carry out this operation in a special room or in the open air.



Figs. 2 to 4.—Bending of a pipe (a) using special bending table and adjustable square (f). The pipe is supported internally by pressure hose (b), inserted prior to heating. Heating is effected by means of hot air under the cover (d). Valves (c) and (g) are in the compressed air line; (e) is the hot air control valve.

By using pressure tubing instead of sand, contamination by dirt and dust is avoided. Thick-walled heat-resisting Perbunan tubes approximately 2 to 3 mm. smaller in external diameter than the internal diameter of the pipe to be bent should be employed. Their length should be such that they extend at both ends of the pipe. Pressure tubing of smaller diameter is connected to both ends of the Perbunan tube (see Figs. 2, 3 and 4), the pressure tubing is inserted into the pipe before preheating and is inflated once the bending temperature is reached, when the pressure tubing will fill the inside of the pipe completely. The bending operation follows immediately After cooling, the pressure tubing is deflated and withdrawn by means of a hook.

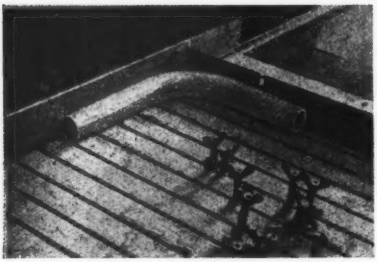
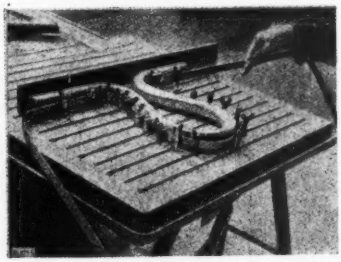
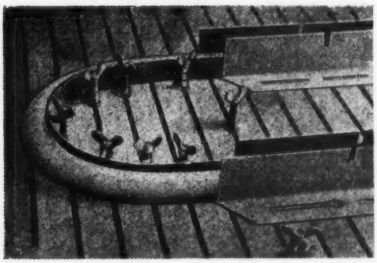


Fig. 5.—Bending of pipe with the aid of a square.

Bending is effected with a template or an angle plate (Figs. 5, 6 and 7). The bending operation should be carried out soon after the correct temperature is reached, and should be followed by quenching with water.

PIPE CONNECTIONS.—Detachable and undetachable joints can be made. In order to save material and to increase the speed of operation, undetachable joints are preferable whenever permissible. Joints can be cut out and replaced whenever an alteration is required. Generally speaking, repairs to Vinidur pipelines are carried out without any difficulty.





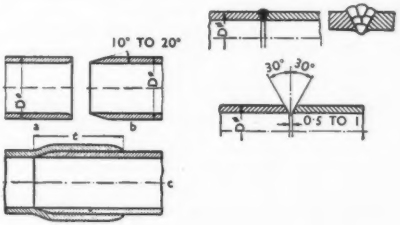
Figs. 6 and 7.—Bending of pipes to templates, using special surface plate. Templates are made from steel tape fixed by adjustable screws. Water cooling follows the bending operation; for this reason the plate is provided with water drainage.

Table 2.—Standard lengths of sleeves for cemented Vinidur pipe joints.

Nominal internal diameter, mm.	3	4	5	6	6	10	15	20	25	32	40	50	70	80	100	125	150
Pipe external diameter, mm.	5	6	8	10	12	15	20	25	32	40	48	60	75	90	110	135	160
Sleeve length. mm.	10	12	15	18	22	25	30	35	42	50	60	70	80	95	110	135	160

Undetachable joints may be made by cementing or by welding. Cemented joints have already been used successfully when welding was still unknown. At the present time, however, double T-pieces, gravity pipes and similar joints are made by welding.[7]

CEMENTED JOINTS.—Cementing can only be carried out for lap joints (cemented butt joints are impracticable). Cemented pipe joints require an overlapping sleeve, details of which are shown in Figs. 8-10; the pipe end to be inserted is bevelled on the outside and the corresponding pipe end on the inside. The pipe end to be expanded is subsequently heated over a length 1.5 times the sleeve length to a temperature of 130 degrees C. Non-uniform or excessive heating can lead to cracking. Following the heating process the other pipe end, which is slightly oiled, is inserted, the sleeve is water-cooled, and the inserted pipe end is withdrawn. Recommended sleeve lengths are shown in Table 2. In order to obtain a good fit it is also possible to expand the pipe with a plug gauge, the diameter of which is approximately 2 mm. smaller than the external diameter of the pipe to be inserted. The latter is preheated over a length exceeding the sleeve depth and is then inserted into the sleeve. Surfaces to be joined are slightly roughened and wiped with a rag soaked in methylene chloride. Following this operation the pipe end to be inserted, but not the interior of the sleeve, is painted uniformly with P.C.20 solution, taking care that the solution does not penetrate inside the pipe beyond the other pipe end. It is preferable to leave a margin 1 to 2 mm. between the bevel and the end of the pipe. The pipe ends are now inserted without twisting. Any excess of solution should be wiped off. It is essential that such a joint should be allowed to set for at least 24 hours prior to use. This refers to normal temperature conditions; setting takes much longer at low temperatures. Slight heating with a flame accelerates the setting process, but should be avoided.



Figs. 8 to 10 (left).—Cemented joint with overlapping sleeve : a, pipe to be expanded, bevelled on the inside; b, pipe to be inserted, bevelled under 10° to 20° on the outside; c, pipe ends inserted into one another (sleeve length t according to Table 2). Figs. 11 to 13 (right).—Preparation and welding of butt V-joint.

Cemented joints obtain their full strength only if the surfaces to be joined are a perfect fit. It is no use filling voids with solution, as this may even affect the material adversely. An excess of solution will lead to deterioration of the material due to softening and swelling.

WELDED JOINTS.—As pointed out previously,[8] welded joints of P.V.C. should only be made for wall thicknesses exceeding 2 mm. Joints should be so arranged that the stress lines are not diverted by the weld. For this reason only butt joints are practicable. Overlapping sleeves used for cemented joints are bad practice for welding (fillet welds should not be employed). The following types of joints have been proved satisfactory:—

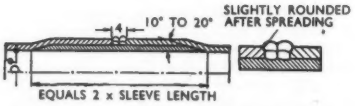
According to Figs. 11-13, pipe ends to

(7) A. Henning, "Welding of Thermoplastics," Kunst. 32/103, 183 (1942).

(8) V.D.I. 2007, "Welding of Thermoplastic Materials."

Fig. 14.—Butt weld with shrink sleeve (V-joint as Figs. 11-13). Sleeve length L = 3D, for D up to 32 mm.; Sleeve length L = 2.5 D, for D 32 to 80 mm.; Sleeve length L = 2D, for D 80 to 150 mm.

Fig. 15.—Preparation of shrink sleeve by expansion of pipe with wooden mandrel.



Figs. 16 and 17.—Welded double sleeve with inserted pipe end.

be welded are bevelled under 30 degrees, so that an enclosed angle of 60 degrees is formed. Welding rods of 2.25 to 3 mm. diameter are used, and a gap (at the root) of 0.5 to 1 mm. should be left. For highest quality welds pipes should be welded in the horizontal position and rotated during welding. The first layer should be deposited very carefully to prevent notch effects, as welding can only be carried out from one side. This first layer should penetrate approximately 1 mm. into the interior of the pipe; such penetration can be achieved by slight pressure on the welding rod. A reinforcement of the weld is desirable, and care should be taken that each rod is welded properly to the preceding layers, leaving no voids. Notches in the transition zone between weld and pipe should be carefully avoided. Dressing of the finished weld is not recommended as it reduces the tensile strength.

The addition of a shrink sleeve protects the weld with regard to excessive bending stresses, and increases the resistance to fatigue (see Fig. 14). The fact that the crown of the weld has to be dressed is not a serious disadvantage in this particular case. The sleeve can be made from the same type of pipe or, in the case of pipes of the 7 atm. range, from pipes of the 3.5 atm. type.

After cutting to size, the sleeve is preheated to approximately 130 degrees C. and pushed on to a greased mandrel the diameter of which is 2 mm. larger than the external diameter of the pipe to be sleeved.

Following this operation the sleeve is quenched in water and withdrawn from the mandrel (see Fig. 15). The weld is made in the same way as a butt weld. Following the welding operation any excess of weld material is machined off and the sleeve is pushed over the welded joint so that the centre of the sleeve coincides with the welded seam. Subsequently the sleeve is heated by means of hot air or a soft flame to shrink it on to the pipes. In addition, the sleeve can be cemented or tack welded at both ends.

Whenever positional welding has to be carried out, i.e., when the pipe cannot be rotated, and it is therefore impossible to align both pipe ends properly and to provide the necessary gap of 0.5 to 1 mm., a double sleeve with a pipe insert should be used (see Figs. 16 and 17). In such cases the inner edges of both pipes should be carefully welded to the pipe insert and the gap between them should be filled with weld material. Bevelling of the inserted pipe piece and expansion of the pipe ends are performed in the same way as for overlapping sleeves.

MECHANICAL TESTS.—In order to investigate the strength of various types of welded pipe joints six different types were subjected to tensile, bursting and bending tests. All the data mentioned already in the previous publication are quoted in brackets in this list. Mean values of this test series were calculated, and will be found in Table 3. All these are short time tests and do not therefore represent actual working conditions. Furthermore, the quality factors for the individual series are not strictly comparable. Variation in the skill of the operators, non-uniformity in the quality of the pipe,

Table 3.—Average quality factors of Vinidur pipe joints.

Denomination	Type of joint	Tensile test	Bursting test	Bending test	
A	Cemented overlapping sleeve. Standard type	1.00	0.49	0.97	0.86
B	Cemented overlapping sleeve. Expanding of sleeve by means of mandrel with diameter 2 mm. smaller than the external diameter of the pipe. Pipe preheated to 130°C.	0.88	0.39	0.82	0.99
C	Unmachined butt weld	0.77	1.00	0.97	0.97
CS.	Butt weld with shrink sleeve. The weld was machined, the sleeve shrunk on only.	0.77	0.94	0.99	0.97
CSS.	As CS. In addition, the sleeve was tack-welded following the shrinking process.	0.77	1.00	0.57	0.96
CSK.	As CS., but in addition to shrinking the sleeve was cemented with PC.20 solution.	0.77	0.93	0.85	0.92

wall thickness, etc., have a far greater influence on quality than that exercised by the type of joint. The experiments show, however, that all types of joints when carried out properly can be used with a satisfactory margin of safety. Practical experience has confirmed this. Joint CSS should only be employed for special purposes as the welding at the sleeve ends may easily damage the pipe. In any case great care must be exercised when shrinking on the sleeve. If the sleeve is a bad fit a joint with a shrink sleeve is inferior to the ordinary butt weld without dressing.

As regards comparison of cemented and welded pipe joints, the cemented joints in general lend themselves better to deformation than welded ones; welded joints on the other hand, are superior to cemented ones as far as bursting tests are concerned.

Regarding ease of fabrication neither of the two types can be given preference. Both require a certain amount of skill and both have their peculiarities. Most plastic plumbers should be able to carry out the cementing of an overlapping sleeve. For gravity pipes and the like, however, at present only welded construction is permissible. Pipes of a wall thickness up to 2 mm. can only be cemented. There are other factors as well which play an important role in the selection of the type of pipe joint. In a factory with fire or explosion hazard even well-shielded electrically heated torches may be dangerous and welding out of the question.

Cemented joints require a certain setting period, if possible 24 hrs., whereas welded joints may be taken into use soon after welding. This is not of great importance for new pipelines but may be an advantage for repair jobs.

Vinidur pipes are occasionally stressed up to the endurance limit or may have to be used just at the safe limit for continuous operation. Cemented joints are not always perfectly inert against chemical attack. In all such cases only welded pipe joints are permissible.

In general, it is advisable for plastic plumbers to acquire the technique for both cemented and welded types of joints.

DETACHABLE JOINTS.—In many cases detachable joints are required, although in practice undetachable ones are usually preferred. The need for detachable joints can occur; for instance, when assembling containers, pumps, expansion joints, and the like. Connections between plastic pipes and pipes of other materials, for instance metal, glass, ceramics, etc., can only be carried out by means of detachable joints.

FLANGED JOINTS.—These are most commonly used and are highly satisfactory. Loose flanges may be made of steel, light metals, laminated materials, plywood or, if required, Vinidur. Figs. 18-20 show the different types of flanged joints. The joint according to Fig. 18

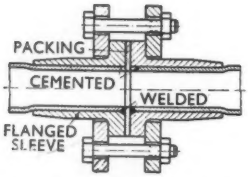


Fig. 18.—Loose flange with cemented raised face flange (DIN. 8067). The raised face flange can be welded additionally as Fig. 21 or 22.

Fig. 19 (left).— Loose flange and welded face ring. (Symmetrical X-joint.)

Fig. 20 (right).—Loose flange with welded face ring. (V-joint with corner weld at reverse side.)

uses raised face flanges (DIN. 8066). These are preheated to approximately 130 degrees and inserted into the bush which is of slightly smaller diameter than the external diameter of the pipes. The joint between pipe and bush is effected by cementing or welding, if necessary by a combination of both techniques. For cementing the same procedure is adopted as for the overlapping sleeve.

Welding is carried out according to Figs. 21 or 22. The welding procedure shown in Fig. 23 is wrong as it causes a reduction in strength at the joint where the pipe is slightly contracted. In the joints according to Figs. 19 and 20 a ring of Vinidur is welded to the pipe end. The procedure according to Fig. 19 should

Figs. 21 and 22.—Correct procedure for welding.

Fig. 23.—Wrong procedure. Reduction of strength through weld near change-over of cross-section.

be given preference unless the joints are not easily accessible, when the procedure according to Fig. 20 is preferable. In order to obtain maximum strength the highest degree of penetration should be aimed at. A weld reinforcement is provided at the face of the pipe, which has to be dressed subsequently. Welding of the other side has to be performed very carefully, leaving a good radius between flange and pipe. Any abrupt change of contour or notches increases the risk of fracture.

Fig. 24 (left).—Welded fixed flange. (Symmetrical X-joint.)

Fig. 25 (right).—Welded fixed flange. (V-joint with corner weld at reverse side.)

Fixed flanges of Vinidur as shown in Figs. 24 and 25 are less commonly used. The welding procedure is the same as that for Figs. 19 and 20.

SCREWED JOINTS.—These are hardly ever used for detachable joints between Vinidur pipes. They do not withstand high pressures and leaks may occur. Where screwed joints cannot be avoided, screwing according to DIN.8066 (Fig. 26) is advisable. In no circumstances should thread cutting be carried out on the Vinidur pipes themselves. When Vinidur pipes are joined to metal pipes by means of flanges, a screwed joint similar to Figs. 27 and 28 can be used. When joining Vinidur pipes to glass, porcelain or ceramic pipes, flanged joints only are permissible.

FLANGES WITH CAP NUTS.—Joining of Vinidur pipes to pipes of other materials by means of superimposed plastic tubing can also be employed when service conditions, such as corrosion resistance, permit. The plastic tubing has, of course, to withstand the internal pressure and should be a tight fit. It is cemented or welded to the Vinidur tube or, alternatively, cemented and welded. The other side of the pipe is fixed by means of saddles. The

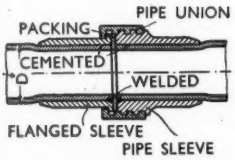
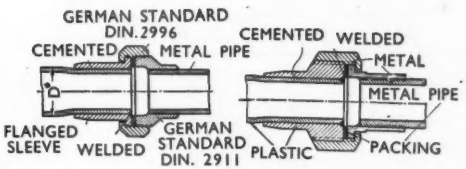


Fig. 26.—Screwed pipe joint for plastic pipes (DIN. 8066). Sleeve, screwed portion, and cap nut are also made from plastic material. Sleeve and screwed part are cemented to pipe and may be welded subsequently. (See also Figs. 21 and 22).



Figs. 27 and 28.—Screwed joint between plastic and metal pipes. The sleeve may be welded subsequent to cementing to pipe.

length of the sleeve should be the same as for cemented overlapping sleeves (see Table 2). The piece of tubing used for the joint can compensate for some heat expansion and also slight movement of the pipes. Occasionally such tube joints have been a success for the connection of Vinidur pipes to vibrating pumps. It should be borne in mind that these tubes have to be exchanged from time to time; they are inferior with regard to pressure resistance as well as resistance to chemical attack.

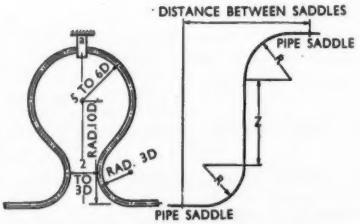


Fig. 29.—(left) Expansion piece (Lyra type). D, external pipe diameter. a, fixing point (supported in pipe saddle). Joints to the expansion piece can be made either by welding or cementing. Fig. 30.— (right) Arrangement of pipe saddles for S bend of pipe run taking care of pipe expansion.

EXPANSION PIECES.—Owing to the considerable thermal expansion (the linear thermal expansion coefficient of Vinidur is approximately 80×10^{-6}, i.e., seven to eight times that of steel), expansion pieces in reasonable numbers should be allowed for. Expansion pieces similar to Fig. 29 with a fixed apex are most suitable. Stuffing boxes appear to be an advantage on account of space requirements. They do not, however, always work satisfactorily, due to variations in temperature between the inside and outside and also on account of non-uniform heating such as results from solar radiation. Stuffing boxes easily spring leaks or cause jams, and are then no longer capable of compensating for linear expansion. The packing material itself may also present difficulties when subjected to strong chemical attack.

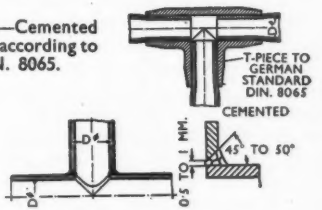


Fig. 31.—Cemented T-piece according to DIN. 8065.

Figs. 32 and 33.—Welded branch pipe.

Corrugated compensators only permit small expansion in cases where a heavy wall thickness has to be chosen for the sake of high internal pressures. They should, therefore, be fitted at short intervals. Elbows of 90 degrees or, better still, double bends can be used for compensation, as shown in Fig. 30. The longer the distance Z the greater the capacity for compensation. The two pipe saddles at the ends of such a double bend must not be used for fixing the pipe, but should

Table 4.—Saddle centres for Vinidur pipes, German Standard DIN.8062.

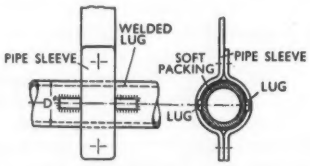
Fluid in pipes	Permissible pressure atm.	Saddle centres m.
Liquids up to 40°C.	1.5 3.5 and 7	1.2 to 1.5 1.5 to 1.8
Gases up to 40°C.	0–7	1.4 to 2

allow a slight displacement in the longitudinal direction. The same applies to 90 degrees elbows.

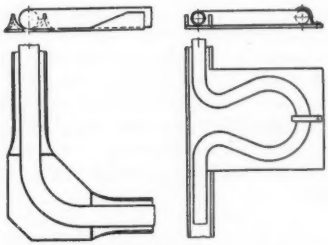
WELDED BRANCHES.—According to DIN.8065 (Fig. 31) tee pieces can be cemented into branches, using a process similar to that employed for cemented overlapping sleeves. More frequently, however, welded branches as shown in Figs. 32 and 33 are used. The branch pipe is not inserted into the main pipe, but butted to it, the bore of the main pipe being equal to the internal diameter of the branch pipe. The latter is bevelled under an angle of 45-50 degrees and welded to the main pipe with a gap of 0.5 to 1 mm., as shown in Fig. 33. Regarding welding procedure, the same applies as for butt welds. Here again dressing of the welds should be avoided. Branches are nearly always made at right angles to the main pipe in order to avoid undue stressing of the welds, and bends are only made at same distance from the weld. Branches welded under an angle should be avoided, as they favour the formation of cracks in the welds.

DETAILS OF PIPE LAYING.—When laying Vinidur pipelines consideration should be given to the large amount of heat expansion as well as the notch sensitivity and the possibility of gradual deformation at temperatures exceeding 60 degrees C. Pipelines should be laid in such a way that they are not exposed to external temperature influences exceeding 40 degrees C. Where it is not possible to keep plastic pipes sufficiently far away from hot pipelines, vessels, apparatus, etc., heat insulation should be used for the Vinidur pipes.

FIXING OF PIPE SADDLES.—Pipelines are usually fixed by means of saddles at distances corresponding to Table 4, unless there is a danger of damage through external forces. Such saddles should permit slight displacement of the pipes in the longitudinal direction. It is recommended to provide the saddles with soft packing of cardboard, soft plastics, rubber or the like, in order to prevent damage to the pipes. Even at fixing points the pipe itself is not held down rigidly by the saddle. Positioning is effected by cemented or welded Vinidur lugs at both sides of the saddle, as shown in Figs. 34 and 35. It is essential to align all saddles accurately, to avoid jamming or stressing of the pipeline. Care should be taken to avoid stresses in the pipeline due to screwed

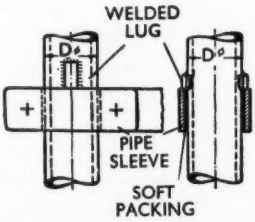


Figs. 34 and 35.—Fixing point with pipe saddle and lugs welded to pipe, cemented to pipe or welded and subsequently cemented. Pipe is held in saddle by means of soft packing.



Figs. 36 and 37 (left).—Design of supporting trough for bend, made from sheet steel. Ends of trough are bent upwards and connected by a straight piece of sheet, permitting unrestrained working of pipes and bend notwithstanding good support.

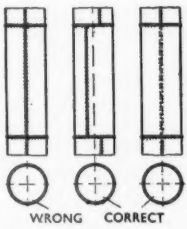
Figs. 38 and 39 (right).—Design of wooden supporting trough for expansion joint. Trough is provided with a board supporting pipe and bend, and permitting unrestrained expansion in all directions.



Figs. 40 and 41.—Support of verticle pipe line by means of saddle with lugs welded to pipe, cemented to pipe, or cemented and subsequently welded. Pipe is held in saddle by means of soft packing.

connections of detachable joints. A simple and reliable check can be made by loosening some flanges, saddles or fixing points, following assembly; the pipeline should then still remain in its original position. The temperature at the time of assembly should be taken care of when assembling expansion pieces. In the case of very high or, alternatively, very low temperatures the expansion pieces should be prestressed in such a way that sufficient movement is possible at both temperature limits.

In cases of higher temperatures which would require very narrow spacing of the saddles and where there is a risk of mechanical destruction, continuous support of the pipeline has been found preferable. Existing structural parts such as girders, sections and the like should



Figs. 43 to 45.—Pipe sections welded together circumferentially from longitudinally welded preformed sheets. Wrong procedure: Double T-welds. Correct procedure: Sections arranged so that no double T-welds result.

be used whenever possible. Generally speaking one should provide troughs which may be manufactured from waste material, e.g., waste timber. Alternatively, thin-walled iron pipes can be flame-cut

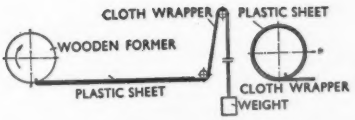
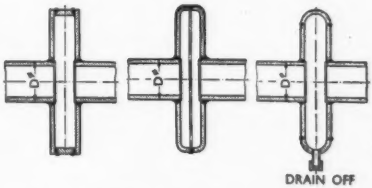


Fig. 42.—Bending device for sheets in fabrication of longitudinally welded pipes. The Vinidur sheet, preheated to 130°C., is bent over the wooden former by wrapping cloth around it. After cooling, it is taken from the former and welded axially.

longitudinally and both halves used. Such troughs should be aligned and fixed properly. When providing troughs for expansion pieces, bends, etc., care should be taken that the pipes do not jam anywhere and that longitudinal expansion or any other movement is not hampered. Figs. 36-39 show a 90 degrees bend in a tubular trough made from metal, as well as an expansion piece held in a wooden trough.



Figs. 46 to 48.—Expansion pieces. Careful welding according to Figs. 11 to 13 is essential to avoid notch effects.

PIPES PASSING THROUGH CEILINGS.—Vinidur pipes should not be cemented into brick walls, ceilings and the like. If the break has to be made good again a sleeve of cardboard or the like is wrapped round the pipe and afterwards a metal pipe of large diameter is cemented into the wall as a support for the Vinidur pipe. Vertical pipelines in workshops should be protected by steel pipes, wooden casings, or the like, against mechanical destruction, up to 2 ft. above floor level.

The weight of vertical pipelines has to be taken by Vinidur lugs which are cemented or welded to the pipe. They

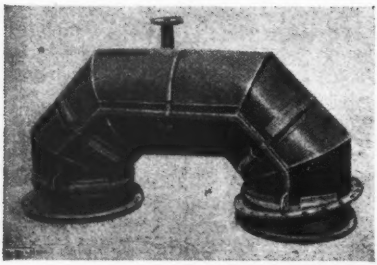


Fig. 49. — Vinidur Pipe: double bend of 540 mm. diam. made from 3 mm. Vinidur sheets. Loading: + 200 to — 100 mm., water pressure at 40° to 60°C.

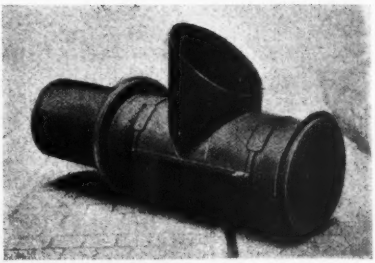


Fig. 50. — Vinidur Pipe: T-piece with expansion piece. (Design and loading as Fig. 49.)

Fig. 51.—Vinidur pipe: Reduction piece (1,100 to 800 mm. diam.) with 540 mm. branch pipe and expansion piece.

are supported by pipe saddles (Figs. 40 and 41). At the lower end of pipes an elbow with a welded support can be used. In order to avoid excessive heating and deformation the welding of the foot should be discontinuous.

Heavy parts such as fittings, valves, etc., should be supported independently so that neither their weight nor stresses caused by their operation are transmitted to the pipe. Such parts should always be made fixing points of the pipeline.

IDENTIFICATON OF PIPELINES.—Vinidur pipelines have sometimes been painted all over for identification purposes and other reasons. This should not be done, as identification is possible without painting the entire pipe, and Vinidur pipes should always be easily recognisable as such so that their handling is compatible with the material. Cases are known where plastic pipes have been manhandled in other ways.

MANUFACTURE.—Pipes of a diameter larger than specified in DIN. 8062 can be manufactured from Vinidur sheets. As far as possible, of course, seamless pipes should be used and two seamless pipes in parallel are preferable to one fabricated pipe of larger diameter.

It is customary to weld the longitudinal and circumferential seams of pipes fabricated from sheet material. Where welding can only be carried out from the outside the first layer should be deposited very carefully. Pipes exceeding 500 mm. diameter should always be welded from both inside and outside. Bevelling should be carried out from one side or both sides according to sheet thickness (see V.D.I. Standard 2007). The sheet thickness depends on the internal pressure to be carried.

A quality factor of 0.5 to 0.6 is recommended for pipes with welded longitudinal and circumferential seams. Generally speaking large diameter welded pipes are only used for low pressures, in most cases for vacuum lines or gas mains with negligible pressure. In this case endless

foils 0.8 to 1 mm. thickness or sheets up to 3 mm. thickness are used. The fabrication of pipes of large diameters requires a large amount of welding as the sheets are comparatively small. Endless foil is to be preferred for this reason. The fact that foil can be bent in the cold state is a further advantage. Pipes made from foil can be either cemented or welded. Bending of sheets can only be done by heating. Of the various methods used for bending the one illustrated in Fig. 42 has proved very satisfactory.

The Vinidur sheets are cut to size and preheated in an oven to approximately 130 degrees C. They are then placed on a cloth. A wooden former with a diameter equal to that of the pipe to be fabricated is rotated and the sheet, together with the cloth on the outside, is wrapped round the former. Both are removed after cooling. The next operation is the welding of the longitudinal seam. Pipe sections fabricated in this way are shop welded together by circumferential seams into pipes of the desired length, care being taken to avoid double-tee joints (see Figs. 43 and 45).

When laying the pipeline individual pipe sections are welded together or sometimes joined by means of flanges. The joint according to Figs. 19 or 20 is given preference.

SUSPENSION.—It is not recommended to reinforce such pipes by means of welded Vinidur webs or ribs, as these do not provide a satisfactory degree of safety. Instead, the method of fixing all welded Vinidur pipes by means of stillages made from angle or flat iron or even timber, has proved very satisfactory in practice. Such stillages of lightweight construction provide sufficient rigidity, and furthermore allow the suspension of the pipes by very simple means. An alternative to this method is the elastic suspension by means of strips of plasticized P.V.C. suspended from steel rods. These strips may also be welded on to the Vinidur pipes and take care of expansion or contraction due to changes in temperature or mechanical vibrations.

Expansion pieces similar to those shown in Figs. 46-48 are the only means of allowing for longitudinal expansion. Hot bending of welded pipes of large diameter is not possible, bends and the like can only be fabricated from segments and are usually assembled by welding.

Figs. 49-51 illustrate practical examples of large diameter pipelines. Frequently it is advisable to use steel pipes lined with Vinidur film instead of welded Vinidur pipes.[9] This is good practice for high-pressure pipelines but may also be used occasionally for unstressed pipelines. The disadvantage lies in the fact that any damage occurring in such lined pipes is difficult to repair, while Vinidur pipelines can be overwelded easily, usually without the need for dismantling.

(9) A. Sirot, "Lining with Vinidur," Kunst. 33/33 (1943). See also V.D.I. 2010.

NEW BRITISH STANDARD

Synthetic-resin bonded-paper tubes are covered by a new British Standard (No. 1314). This supersedes the relevant portion of British Standard (No. 316) published in 1929 for synthetic-resin varnished-paper boards and tubes for general electrical purposes.

Three types of circular tubes are dealt with, the internal diameters ranging from ¼ in. up to 3 ins. The tubes are intended for electrical insulating purposes for use on power circuits with direct current, and with alternating current for frequencies up to 100 cycles per second. Type A is characterized by a low water absorption, high resistivity and good machining properties. Type B has a greater radial electric strength at high temperature than Type A; it also has higher water absorption, and is in general less brittle than Type A. Type C has a greater radial electric strength than either A or B; the water absorption is greater, and its machining properties are inferior to Type B. Part 2 of the specification contains optional clauses dealing with electric strength of tubes with wall thickness above ¼ in. and power factor. The methods of test are fully described.

Copies of this specification (B.S. 1314-1946) may be obtained from Publications Dept., British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s.

PLASTICS IN PRINTING

By E. S. Hole

On May 27, the author, who is inventor of the "Holite" plastic printing plate, delivered one of the first post-war series of terminal lectures for the Printing Trade Classes at the Medway School of Arts and Crafts. His reference to pioneer experiments in the utilization of synthetic resin for printing plates makes interesting history.

PLASTICS is not a new thing in printing; printing may be said to have sprung from plastics, as proved by the discovery of clay tablets of the Babylonian era with their impressed cuneiform characters. In the modern sense the thing began with celluloid. Even so far back as 1880 Emil Jannin produced printing plates from celluloid, his matrix being made with a quick-drying compound made from glycerine and certain metallic oxides. Owing to their small resistance to heat and their great inflammability, however, these plates never became popular.

When acetate began to replace nitrate in the composition of a suitable material, and inflammability was counteracted, attention was quickly turned to this new material. About 1905, Otto Richter, a Swiss, employed by the Rudolf Mosse organization in Berlin produced printing plates from this material. These plates had very small resistance to heat, and as printers almost exclusively took duplicates from a plate by moulding a matrix in a hot press, they were not welcomed in newspaper usage, where from a single plate it might be needful to reproduce several more for use on additional presses. There was the further problem of the production of a suitable matrix, because the moulding by heat of a thermoplastic plate from a thermoplastic matrix presented difficulties.

I came into contact with this problem during the war of 1914-18. In 1914, I made a tour of Europe and found that the enemy pictorial propaganda was widespread and our own was non-existent. In that war the only possible appeal to the illiterate was by means of the cartoon, and of this fact the enemy propagandists were well aware. In 1915, having failed to interest the Foreign Office in the matter, I decided to do it myself, and I circulated innumerable cartoons to the allied and neutral Press. From all parts I received letters saying that neither "clean proofs" nor "flong matrices" were of any use, and what they required was the printing plate itself. Throughout the course of that war I was unable to make use of printing plates, because metal stereos and electros were too heavy. So I set out to find a way of making a printing plate which could be sent by letter post—i.e., a "flong" plate instead of a flong matrix.

About 1924 I read in Geoffrey Martin's "Industrial Chemistry" some references to "synthetic resin" (nobody talked of "plastics" then), with the statement that under the influence of heat such material first became temporarily soft and then permanently hard. That seemed to answer my requirements and without knowledge of chemistry I began to experiment. By 1926 I had evolved a method of making successively both matrix and plate by the use of impregnated cellulose with the thermosetting compound which I called "Holite."

In 1928 I received a letter from Josef Richter, of Geneva, who said that he had seen some of my printing plates in a newspaper office. He, too, made printing plates, but his plates were made with thermoplastic material from a thermoplastic matrix, which soon deteriorated. If he could make his plates from my matrices he would be able to produce them in unlimited numbers. Thus began the production of thermoplastic plates from thermosetting matrices. For my part, however, I kept to the thermosetting plate, from which it was possible to print direct or to take matrices for stereotyping without any fear of the plate being affected by the heat.

When applying for my 1926 patent I found that there had been previous workers even in that field, but to me their patents did not seem to be very practical, whereas my own, from the onset, was exploited on commercial lines. From 1932 to 1934 I ran a service of topical pictures, 1/50 in. or 0.5 mm. thick, to be fastened to mounts or cylinders by means of a suitable adhesive, rather like a postage stamp. It was successful technically, but not so commercially.

When the war began in 1939, with a much greater need for propaganda than there had been in 1914, one of the principal instruments chosen was the thin printing plate with an adhesive backing. Of these plates, many millions—both thermoplastic and thermosetting—were used. Holite being nearly eight times lighter than stereo metal, and the 0.5 mm. printing plates eight times thinner than the ordinary metal stereo, means for printing propaganda during 1939-45 were 64 times lighter than those which were available in 1914-18.

Reproduction of " plates " is one thing; the reproduction of formes of types is quite another, and has bristled with difficulties from the onset. Each of those difficulties has been overcome, and the plastic plate as a medium for printing is now well established. A good thermosetting plate will outwear easily any of the metals ordinarily used in printing.

For many years, however, I was faced with one problem of extreme difficulty, namely, the production of rotary plastic plates. This has now been overcome by the expedient of moulding the plate from a curved matrix between curved platens, but for a long time the value of this invention was almost nullified by the need to make platens of different peripheries to adapt the rigid plates to the varying periphery of the cylinders. Some time ago it occurred to me that this might be overcome by making a plate with a Holite sheet as the face and a sheet of rubber as the back, but I found that, though " flexible," such a plate was not " bendable."

Much more recently it occurred to me that if such a plate were moulded between curved platens of almost any periphery, the pre-curved plate might adapt itself to any other periphery. I found that it will do so with ease. This method, which I have recently patented, promises to have great importance in the field of rotary printing in general. Though not put forward as a practical means of printing daily newspapers it may still have its uses for the printing of special features in such newspapers.

The plastic plate has many advantages. There is no melting of metal. The sheets are always ready, and the application of heat and pressure will give you either matrix or plate. The plates have an affinity for ink. They can be sawn, drilled and bevelled with the ordinary tools of the stereotyper, but for planing and routing it is necessary to have tools with tungsten carbide or other hard tips. The plates are impervious to the action of acids, lyes, or any chemicals in the inks used for colour-printing. The matrices, moreover, are practically indestructible.

HORNERS' COMPANY LECTURES

The first lecture on plastics, founded by the Horners' Company, was given by Mr. C. F. Merriam at Vintners Hall, London, on July 5. The Master of the Horners' Company, Mr. G. C. Hellyer, presided. Mr. Merriam, who is chairman of the British Xylonite Co., Ltd., B.X. Plastics, Ltd., and Halex, Ltd., and chairman and managing director of Cascelloid, Ltd., said that it was an inspired thought to associate plastics with the ancient craft of the Horners, for there was a touch of similarity in the problems of the old craftsmen and the present-day workers in plastics. In 1761 horn was softened over fire, cut, and pulled apart until it was flat. The horner then placed the horn between hot-iron plates and pressed it until the required thinness was obtained.

TESTS ON PLASTIC SHEETING

Results of the first tests on thin plastic sheeting for raincoats, curtains, etc., will be given to members of the Retail Trading Standards Association in the " Bulletin " issued by the Association's trade information service. Further bulletins will be issued throughout the summer dealing with other types of " soft " plastics.

LETTERS TO THE EDITOR

A Plan for Sharing Stock Moulds

Sir,—In our business as designers, we do a considerable amount of plastic mould tool design. Some of our clients, particularly those who are entering the plastics field for the first time, are concerned at the time taken to produce the mould after it is designed. There is, of course, a minimum time for the manufacture of any type of mould, but at present manufacturers are working to capacity, which adds considerably to the time needed.

There have been several cases, however, where we are sure that almost identical items have been produced in the past, and that a very simple alteration to existing moulds could be carried out, or our clients' designs could be altered slightly to utilize existing moulds.

To quote examples, we recently designed a mould for a small plastic shroud which was turned down solely because of the time it would take to produce the mould, and the whole job was redesigned to eliminate the shroud, though its incorporation would have resulted in a better article. We were of the opinion that the mould used for the plastic eye-bath would have been suitable, the sizes were almost identical, the shroud sizes were not critical, and a simple machining operation would have done the job. This suggestion was turned down because we did not have the information as to the manufacturer of the eye-bath or holder of the mould readily available.

Again, we recently had an inquiry about the design and manufacture of moulds for two types of handles, one of which was similar to a lever-type door handle which we have seen in use, and are of the opinion that there are moulds in existence which could have been used. We have also been asked by one of our clients if we can find out if any firm has available the moulds for producing the standard electric lamp bayonet socket.

In view of the foregoing, we have conceived the idea of compiling a catalogue of stock moulds. Could not some publicity be given to an appeal to firms to forward details of moulds held in stock from past or present products, which they would be willing to hire out or sell, or from which they would be prepared to produce mouldings?

Altrincham. CROWTHER BROS.

[EDITOR'S NOTE: The idea is, on the whole, an excellent one and, as is well known, has long been carried out in America to a limited extent and has been considered here. Many moulding concerns have such tools in stock which never see the light of day and are eventually scrapped. There are many snags, especially the creation of a formula between lender and borrower. One thing, however, is certain, the production of a catalogue with drawings of stock moulds by an official or semi-official body, made readily available to moulders and customers alike, would not only be of economic value, but an important saver of time and labour in this very difficult period. The correspondents are to be thanked for bringing up this problem once again.]

Plastics for Industrial Plant

Sir,—In his articles appearing in the June and July issues, Mr. C. H. Butcher dealt in most interesting manner with the use of phenolic and other resins for the protection of plant against chemical erosion. He summarized the employment of plastics for this purpose, but omitted any mention of polythene, which is now generally admitted to be one of the most inert of plastics at present available. Its properties include complete freedom from chipping when used as a lining for vessels, etc., and resistance to hydrofluoric acid and even organic solvents when it is used under normal conditions.

Polythene is commercially available in many forms under our proprietary name of "Telcothene," and these include piping up to 1½ ins. bore, moulded fittings for piping, etc., sheet, film and powder for spraying by the Schori process. Vessels of any shape and size can now be pro-

vided with a coating over a wide range of thicknesses and in many colours without the use of solvents or any curing process.

We feel it necessary to bring these facts to your attention in view of the many chemical and economical advantages of this material, which has been the subject of extensive development since the end of hostilities, and which is now in everyday use in the electrical, chemical, brewing and soft-drinks industries.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE CO., LTD.
Greenwich, S.E.10.

[EDITOR'S NOTE: The value of polythene for the manufacture of plant in contact with chemicals was well known to both Mr. Butcher and ourselves. However, he was unable to obtain data regarding its performance and application, so that we hope it will be dealt with adequately on a future occasion.]

"Plastic" or "Plastics"

Sir,—Your article on "language muddle" in the industry (May, 1946) does well in ventilating inconsistencies in the jargon of plastics. I hope you will see fit to go further and try to set up some standards. As one whose duty it is to publicize plastics products, also as one who spent much time on the editing of dictionaries, I am continually distressed by the use of the words "plastic" and "plastics."

It is clear from the general dictionary definition that a product of the plastics industry is not itself "plastic" but "plastics." Except in a few cases, the product is *rigid* and far from plastic. I suggest that the old word plastic, either as noun or adjective, should be kept to its old sense, i.e., moulding or capable of being moulded (plastic arts, plastic surgery, etc.), and that we should regard the word "plastics" as a new word. Thus, whether used as noun or adjective, "plastics"—with an "s"—would be *our* plastics. The "s" would not be used in the sense of plural.

It seems to be better to say that an article is plastics rather than plastic, if you mean that it is a product of the plastics industry—if for no other reason than that certain products may be both "plastic" and "plastics." The distinction is surely worth preserving?

C. CLARK RAMSAY.

E. K. Cole, Ltd.,
Southend-on-Sea.

Sheet or Foil

Sir,—We have read with interest your useful editorial comments, in the May issue, on the paper presented by Mr. E. L. Midwinter and myself to the Institute of the Plastics Industry, April 23, 1946. These comments raised some important points on the vexed questions of standardization of units and terminology.

There are two points to which we would venture to draw your attention, since they might lead to misconception in the minds of some of your readers.

In your editorial you refer to foils being less than 0.015 in. in thickness, the implication being that 0.015 in. is the maximum thickness for foils. This limit was, in fact, given in the paper as the maximum for film, the limiting thickness for foils being 0.00099 in. As I mentioned in the discussion following the paper there is no suggestion that this terminology constitutes a standard, but it has some usage.

I feel that the reference to films in metallurgy is hardly relevant, since the very word "film" has an entirely different significance to the metallurgist, who considers it in its scientific sense, i.e., as a layer perhaps a few molecules in thickness.

We do feel that the standardization of terminology for all industries and sciences demands a simplification which is hardly justified by the diversity of properties of the material handled.

R. K. REYNOLDS.

I.C.I., Plastics Division,
Welwyn Garden City, Herts.

[EDITOR'S NOTE: We regret our error in describing the limiting thickness of foil, film and sheet given by Mr. Reynolds during his lecture. Our main fear, how-

ever, was that p.v.c. 5/1000 to 10/1000 in. thick, known generally to most plastic manufacturers and to most of the big buyers in the textile industry as "p.v.c. sheet," should become known to the public (on Mr. Reynolds's terminology) as a form which might be construed by the public as being inherently weak, namely, "p.v.c. film." In the celluloid industry we believe the lower limit of sheet is 10/1000 in.]

Perspex Cigarette Cases

Sir,—Referring to the July issue of "Plastics" (page 349), may we draw your attention to the fact that we have been making Perspex articles for the civilian market in large quantities for some time, including cigarette cases, and we should be grateful if you would kindly include our name in future lists of manufacturers of this nature, mentioning the Light Engineering Division.

THE BRISTOL AEROPLANE CO., LTD.
Bristol.

Plastic for Lampshades

Sir,—We shall be glad if you will advise us of firms who supply plastic sheet suitable for making lampshades, etc.

Rugby. J. TALLON AND SONS, LTD.

[EDITOR'S NOTE.—Cellulose acetate sheet can be obtained from British Celanese, Ltd., B.X. Plastics, Ltd., and M. and B. Plastics, Ltd., all of London. A new material called "Crinothene" (polythene), made by Imperial Chemical Industries, Ltd. (Plastics Division), would also be very suitable for your purpose.]

Interlaced Seats for Stools

Sir,—We are looking for a plastic material suitable for covering the tops of stools, replacing hide. We want this material in strips about 1¼ ins. wide, in brown and green, and we should interlace the strips across the seat and secure at the edges with brass-headed nails. The material should not have much stretch about it. Would you tell us where we may obtain material of this kind?

H. J. BERRY AND SONS.
Chipping, near Preston.

[EDITOR'S NOTE.—The material which you require is p.v.c. (polyvinyl chloride), either in form of extruded strip or in sheets which may be cut into strip; the latter would be the cheaper of the two alternatives. As there will be a desirable minimum thickness to prevent sagging, we suggest that you put your problem before the manufacturers of p.v.c., with a view to obtaining their suggestions. In sheet form, p.v.c. is obtainable from Imperial Chemical Industries, Ltd. (Plastics Division); Vinyl Products, Ltd., Carshalton, Surrey; P. B. Cow (Queensbury), Ltd., Stanmore, Middx.; Pirelli-General Cable Works, Ltd., Eastleigh, Hants. Duraplex (Plastics), Ltd., Burwood House, Caxton Street, S.W.1, supply extruded strip of any desired cross-section.]

Strip for Toy Reins

Sir,—We are looking for a manufacturer to supply plastic strip, various colours, ½ to 1 in. width and heavy enough to use for children's toy reins and pram harness. If you can put us in touch with a source of supply we should be grateful.

MERSEY LEATHER GOODS CO., LTD.
Beckington, Somerset.

[EDITOR'S NOTE.—Duratube and Wire, Ltd., Fagg's Road, Feltham, Middlesex; Tenaplas, Ltd., Upper Basildon, near Pangbourne, Berks.]

Water-lubricating "Glide Metals"

Sir,—We have received an inquiry from Holland for water-lubricating "glide metals" made of Bakelite, needed for the 3-in. shafts of machines making crêpe paper. We shall be obliged if we could contact a firm actually manufacturing this type of material, to obtain samples and prices for export.

A.B.C. PLASTIC MOULDED PRODUCTS.
London.

Inquiries for Trade Names

We have received inquiries for the names and addresses of firms using the following trade names. Replies should be communicated direct.

CARVACRAFT. — Inquiry from D. Matthews and Son, Ltd., 14-16, Manchester Street, Liverpool, 1.

OMNISEAL plastic compound.—Inquiry from Levetus, Ltd., 194, Bishopsgate, London, E.C.2.

GALA and LAMPIC ware.—Inquiry from Seeby Rural Crafts, Ltd., Reading.

YOUR REPUTATION WAS NOT WON BY CHANCE . . .

Even at the best of times, maintaining a reputation is a long and arduous fight against the alleged fickleness of public opinion. However, success usually comes to the man who knows that this thing some people call fickleness is simply the public expression of sound judgment. It is on that judgment that the continued reputation of your product depends. And, having achieved success, the slightest variation in your established quality . . . the merest deviation from an essential specification and, just like that, you're in danger of losing a customer—and your reputation.

That's quite a responsibility for any man to carry—but one that Monsanto, in preparing their products, readily accepts without a qualm. But then, Monsanto has good reason to accept it. Every batch of every Monsanto chemical is *double*-checked by our highly skilled control chemists before a single pint or a single pound is delivered to your works.

Phenol ; Phenol mixtures ; Cresols ; Phthalic anhydride ; Diethyl Phthalate ; Dimethyl Fhthalate ; Dibutyl Phthalate ; Tricresyl phosphate.

But there's even more to it than that: most Monsanto chemicals are prepared to much closer specifications than those required by B.P. or B.S.I. So, with a high standard to start with, and with that high standard as an integral part of your formulae, you will readily appreciate the important part that *double*-check-controlled Monsanto chemicals play in helping you to maintain your reputation.

MONSANTO CHEMICALS

MONSANTO CHEMICALS LIMITED
Victoria Station House, London, S.W.1
Telephone: Victoria 2255
Telegrams: Monsanto, Sowest, London

SERVING INDUSTRY
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THE MICANITE & INSULATORS COMPANY LTD.

Empire Works, Blackhorse Lane, Walthamstow, London, E.17.

Manufacturers of MICANITE (Built-up Mica Insulation). Fabricated and Processed MICA. PAXOLIN Laminated Materials. EMPIRE Varnished Insulating Cloths and Tapes. HIGH-VOLTAGE BUSHINGS and TERMINALS. Distributors of Micoflex-Duratube sleevings and Micoflex Durasleeve (plastic covered flexible metal conduit)

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PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

NEW TERPENE RESINS.—Cornelius Chemical Co., Ltd., of Ibex House, Minories, London, E.C.3, are supplying a new series of pure hydrocarbon thermoplastic terpene resins of American origin, which they call non-yellowing "V" resins. Already they have small stocks available, with melting points 70, 85, 100 and 115 degrees C., but are hoping to import regularly. These "V" resins are composed essentially of polymers of selected unsaturated terpadienes. They are inert to dilute acids, unattacked by 10 per cent. alkali, and show no darkening in colour when held for six hours at 310 degrees C. The molecular weight varies with the melting points, averaging 650. The specific gravity is low (0.98 to 1.00). In the complete range the melting points vary from 10 to 125 degrees C. (ball and ring softening point method).

Regarding solubility, 40 parts of resin will remain in 60 parts by weight of petroleum and coal tar solvents, mineral oils, chlorinated hydrocarbons, high-boiling esters and long-chain alcohols, when allowed to stand at ordinary temperatures after having been warmed into solution. They are insoluble in most ketones (excepting long-chain ketones), low-boiling esters and short-chain alcohols.

As regards compatibility with other materials, "V" resins have been found compatible with many waxes, including the long-chain alcohol-fatty acid types; paraffin wax is noticeably compatible; likewise the hydrogenated fats and fatty acids. They have been tested and found compatible with rosin, metallic resinates, ester gums, coumarone-indene resins, and a number of modified glycerol-phthalate and phenolic types based on rosin and ester gum and drying oils; also with polybutylene and some of the chlorinated rubbers and resins. Petroleum residues, soft tar residues, and the pitches resultant from oil refining are mainly compatible. Unlike most others, the new "V" resins are very soluble in paraffin-type oils, including white mineral oils. They have been found compatible under suitable conditions with rubber, vistanex, gutta percha, and certain chlorinated, polymerized and resinified rubbers.

Dissolved in any usual manner and especially in petroleum thinners, the solutions may be further diluted in very low concentrations without danger of precipitation from the solvent.

In varnish manufacture, "V" resins may be used in the cook or as a check. Under kettle conditions the resins actually bleach to a slightly lighter colour. They have only a slight holding effect on the gellation of china-wood and similar-type oils; and this advantage also shows up in the final film formation on a surface, resulting in unusually tough coatings. Any driers used should be of a soluble nature. The excellent solubility of the resin in petroleum naphtha is an aid in many varnishes. The body of a 50 per cent. by weight solution of "V" resin is about the same as linseed oil.

We have also received from the Cornelius Chemical Co. some technical notes on the coumarone-indene and coumarone-styrene resins. Both of these are obtainable in three grades of colour, the matter insoluble in pure xylole being approximately 1 per cent. Except for this small amount, both series of resins are completely soluble in a wide range of the usual solvents. While the coumarone-indene series, however, are completely soluble in linseed, tung, soya-bean and other drying oils, the coumarone-styrene series under like conditions are insoluble. Of the two, the styrene series give more viscous solutions. The indene series, however, have the highest dielectric strength, which is 700 to 900 volts per mil, compared with 300 volts per mil in the case of the styrene series.

B.X. PLASTICS, LTD., is disposing of its plastic film section to a recently formed private company. Registered under the name of Bexford, the new company has a capital of £200,000 in £1 shares. B.X. Plastics, Ltd., and Ilford, Ltd., are entitled to appoint an equal number of directors.

HELVIN PLASTIC MATERIAL. — Hellermann Electric, Ltd., Oxford, have issued a leaflet dealing with their rubber-like plastic from which parts in a wide range of shapes and sizes can be produced without entailing trouble or tool costs. Helvin is a thermoplastic based upon co-polymers of vinyl chloride. It can be used for pressing manufactured goods, such as coils and con-

densers, to make them waterproof or suitable for tropical climate. During the war years the company made millions of cable sleeves from this material, and are now making a range of articles for which a post-war demand is developing.

MONSANTO CHEMICALS, LTD.—Mr. W. Morgan Thompson has been appointed home sales manager. This appointment, new to Monsanto, is the immediate result of the company's rapidly expanding business in Great Britain and Northern Ireland. Mr. Morgan Thompson joined Monsanto in 1933 as a sales representative. The fact that he was a Territorial officer when the war broke out, temporarily severed his active participation in the company's affairs. Since leaving the Army he has been in charge of Monsanto fine chemical sales. His new appointment became effective at the commencement of July, under Mr. Alfred D. Daysh as sales director and Mr. Douglas R. Mackie as general sales manager.

PORTLAND PLASTICS, LTD., announce that they have acquired showrooms at 6-12, Victoria Street, Westminster, S.W.1, for the display of their products, and are desirous of co-operating with any other British manufacturers of plastics who may care to take advantage of this centre to publicize their wares.

FRANCIS SHAW AND CO., LTD.—Mr. M. R. Rhodes, A.M.I.Mech.E., has been appointed representative for London and South-East England, to succeed the late Mr. J. W. Howie, whose death was announced recently. Mr. Rhodes has been employed by the company for 19 years, and has latterly been one of their technical engineers for the North of England. He will operate from 84, Woodbourne Avenue, Streatham, S.W.16, until further notice.

DUNLOP RUBBER CO., LTD.—Dr. D. F. Twiss has just retired after 32 years' service as chief chemist to the company. Until 1914 he was lecturer in chemistry at Birmingham Municipal Technical School. In 1934 the Institution of the Rubber Industry, of which Dr. Twiss is vice-president, awarded him the Colwyn Gold Medal.

W. S. DAHL, 30, Stanley Road, Mortlake, London, S.W.14, informs us that he has been appointed sole agent of The Portland Import and Export Co., Portland, Oregon, U.S.A., for the sale of their walnut shell powder and Idaho white pine woodflour in Great Britain, Colonies and European countries.

SCOTTISH PLASTICS, LTD., have reduced their labour force at Strathendry, Leslie, Fife, consequent on their decision to transfer certain lines to the main English works. Thomas de la Rue and Co., Ltd., owners of this factory, were recently approached by the Board of Trade to prevent the factory from being closed. The work of making radio cabinets and telephones is being transferred to London, and the Scottish factory is to increase fountain pen production.

BIRKBYS, LTD.—The sudden death is announced of Mr. J. Blakey, for many years technical representative of this company in the north-western area.

E. K. COLE, LTD.—The annual sports meeting was held on Saturday, July 27, and competitors from many well-known athletic clubs took part in the open events. In the men's 440 yds., E. Heaton, of Ekco Plastics Division, finished first with a time of 57.2 seconds; third and fourth places were also secured for the Plastics Division. Prizes were presented by Mrs. E. K. Cole.

BRITISH THOMSON-HOUSTON CO., LTD.—Mr. Hugh Warren, M.Sc., M.I.E.E., of Thurlaston Grange, Rugby, present managing director of the company, and formerly director of the company's research and engineering section, has received the degree of Doctor of Science, *honoris causa*, at Birmingham University. He is a member of several scientific and industrial committees. His award of a doctorate recognizes in particular his work in industrial research and technical education.

IMPERIAL CHEMICAL INDUSTRIES announce that their Southern Region Sales Office has removed from Mill Hill to Gloucester House, 149, Park Lane, London, W.1 (phone, Grosvenor 4020), to where all correspondence should now be addressed.

BAKELITE, LTD., held their annual general meeting on June 27. Reporting on the company's progress, Mr. H. V. Potter, managing director, said that, following the transfer of production from war to peacetime footing, it had been anticipated that there would be a slight falling off in the demand for moulding materials, which would be recovered. The demand, however, had been sustained, and had increased rapidly to record proportions. On the laminated plastics side a considerable curtailment in demand had also been anticipated; this had occurred immediately following the cessa-

tion of hostilities, but the position had now improved considerably.

The manufacture of decorative laminated plastics, discontinued during the war, had been recommenced, and was being handled by a subsidiary company, Warerite, Ltd. The demand for Warerite for shipbuilding and ship repair work, railway coachwork and other priority work had been gratifying; an outstanding example of the use of this material was to be seen in the Trianon Bar on the "Golden Arrow" boat train.

The company, continued Mr. Potter, was now seriously handicapped by the shortage of raw materials, particularly phenol, wood flour and paper. It had been necessary to import phenol from America, despite being a by-product of coal. The difficulties of importation, frequently caused by the slowness of Government Departments in issuing permits, had delayed the company's production programme and prevented it from reaching a new peak of production which might otherwise have been attained.

The company was in process of closing down the dispersal plants established during the war, and reconcentrating at the main factory at Tyseley, Birmingham; also at the Ware factory and on a new 38-acre site at Aycliffe, Co. Durham. Plant which could not be accommodated at Tyseley would be used at Aycliffe, along with new equipment required for the manufacture of vinyl plastics and urea moulding materials.

PAPERS FOR PLASTICS, 1939-45.—Wiggins, Teape and Alex. Pirie, Ltd., have sent us one of the brochures which their export company is distributing through its overseas branches to large consumers of paper abroad. It gives a record of the company's achievement during the war years 1939-45, and emphasizes that the war effort from the industrial point of view could not have been prosecuted successfully without manufactures into which large quantities of paper entered. The brochure, to be printed in English, Spanish and Portuguese, is produced in an admirable manner, with numerous photographs of war damage suffered by the company's buildings in London, Manchester, Liverpool, Bristol and other parts of England. Uses of paper in the war effort are outlined, accompanied by appropriate illustrations. The name of Wiggins Teape has had a long tradition in the paper-making industry, with a manufacturing capacity of 18 mills. The company was therefore in a unique position to supply almost any kind of sheet demanded. In the forefront among these was paper supplied to the plastics industry. Not only did the war extend the use of paper in this direction, it also called for the use of different types of paper base with special resins according to the purpose of the final product. Production jumped three-fold. The company thereby gained valuable experience which will be utilized profitably to prepare such papers demanded in peacetime developments.

INSTITUTE OF THE PLASTICS INDUSTRY.—The address of Mr. Walter W. Davies, hon. secretary of the Midland Section, is now Winds Crest, Aqueduct Lane, Alvechurch, Worcestershire. Telephone: Hillside 1535.

I.P.I. GOLFING SOCIETY.—The London Section announce the following fixtures:—

Tuesday, September 17.—All-day meeting at Hindhead Golf Club, Surrey, to compete for trophies to be determined.

Thursday, September 26.—Match against the Birmingham Section at Little Aston Golf Club, Birmingham.

LONDON SHELLAC RESEARCH BUREAU

Sir,—My attention has been drawn to a notice in the technical Press which refers to the "winding-up" of the London Shellac Research Bureau. That notice is premature. Both the Indian Lac Cess Committee and the Government of India are at present considering the future of lac research in the United Kingdom, including the location of a research laboratory and the scope of the research work to be undertaken.

Dr. B. S. Gidvani has returned to India on termination of his contract with the Indian Lac Cess Committee. Meanwhile, Mr. A. J. Gibson, who was the Special Officer, Lac Inquiry, from 1929 to 1943, has very kindly consented to deal with inquiries on lac, and letters or telephone calls to India House, Aldwych, W.C.2 (Temple Bar 8484), will continue to receive attention as in the past.

I shall be most grateful to you if you will give appropriate publicity to this statement of the present position.

DAVID B. MEEK,
India Trade Commissioner.
India House, London, W.C.2.

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 577,208. Application date: 19.11.43. Accepted: 9.5.46.

Improvements in or relating to the Electric Heating of Dielectric Materials. A. J. Maddock. To: Standard Telephones and Cables, Ltd.

B.P. 577,290. Application date: 2.12.43. Accepted: 13.5.46.

Improvements in or relating to Containers for Liquids or the like. To: British United Shoe Machinery Co., Ltd.

Laminated fuel tank.

B.P. 577,291. Application date: 8.12.43. Accepted: 13.5.46.

Process for Uniting Rubber to Textile Fabrics. G. M. Hamilton and C. H. Suchy. To: Callender's Cable and Construction Co., Ltd. Callender-Suchy Development, Ltd.

Bonding of rubber to textiles by plating a metal which is attacked by sulphur (i.e., brass) on to the textile and applying a vulcanizing treatment.

B.P. 577,317. Application date: 27.11.42. Accepted: 14.5.46.

The Manufacture of Styrene Polymers and Interpolymers. R. G. R. Bacon and D. D. Kelly. To: Imperial Chemical Industries, Ltd.

Relates to the polymerization of styrene alone or in admixture with other substances of a polymerizable olefinic nature, in aqueous medium in the presence of persulphuric acid or a water-soluble persulphate and an oxy-acid of sulphur with reducing properties, or its water-soluble salts or their addition compounds with aldehydes or ketones (sodium hydrosulphite or sodium sulphite).

B.P. 577,322. Application date: 21.6.43. Convention date (U.S.A.): 23.6.42. Accepted: 14.5.46.

Improvements in and relating to Resinous Polymerization Products. British Thomson-Houston Co., Ltd.

B.P. 577,326. Application date: 12.1.44. Accepted: 14.5.46.

Polymer Dispersions. R. G. R. Bacon, H. Taylor and L. Wood. To: Imperial Chemical Industries, Ltd.

Refers to polyvinyl chloride-polystyrene dispersions suitable for dipping.

B.P. 577,350. Application date: 16.1.43. Convention date (U.S.A.): 30.1.42. Accepted: 15.5.46.

Improved Process relating to the Polymerization of Olefinic Materials. Standard Oil Development Co.

Refers to olefinic polymers and in particular to interpolymers of an iso-olefin with a di-olefin and to means for improving handling and processing characteristics of such interpolymers. Improvement can be achieved by adding a water insoluble metal salt (zinc stearate, aluminium stearate or magnesium stearate) to the olefinic materials before or in the course of polymerization; the polymers so produced are obtained in a finely divided form suitable for drying or subsequent mechanical working.

B.P. 577,432. Application date: 11.2.44. Convention date (Switzerland): 26.1.43. Accepted: 17.5.46.

A Process for the Production of Bubble-free Bodies from Synthetic Material. R. Staeger.

Production of bubble-free structures from high polymers in the form of plates or powders by wetting with a minimum (5-15%) of low molecular materials capable of polymerization or condensation, and subsequent compression in order to expel air. The resultant mass is converted into a solid compact by polymerization or condensation of the low molecular material. Examples given are: methyl methacrylate wetted with monomeric methyl methacrylate containing benzoyl peroxide; phenol formaldehyde in the fully hardened condition wetted with precondensed products; or phenol resins wetted with condensable solutions of hexamethylene tetramine, and a few others.

B.P. 577,433. Application date: 21.2.44. Accepted: 17.5.46.

An improved process for rendering Nylon Fabrics Water Repellent. C. Dunbar, G. Landells, C. A. Norris and R. J. Smith. To: Imperial Chemical Industries, Ltd.

Production of new finishes on nylon fabrics, also water repellent effects.

B.P. 577,467. Application date: 2.12.43. Accepted: 20.5.46.

Improved Method of and Apparatus for

Moulding Articles particularly Lenses from Thermoplastic Materials. American Optical Co.

B.P. 577,472. Application date: 4.4.44. Accepted: 20.5.46.

Improvements in and relating to the Preparation of Hydrogenated Rubber. K. C. Roberts and J. Wilson. To: The British Rubber Producers' Research Association.

Refers to the preparation of hydrogenated rubber and in particular to rubbers or molecular weights varying from 100,000 to 200,000, suitable as insulating material. A nickel Kieselguhr catalyst is used for the reduction of the rubber in cyclohexane by hydrogen under pressure. Acetic acid is added to flocculate and coagulate the catalyst and in order to facilitate its removal by filtration.

B.P. 577,474. Application date: 22.4.44. Accepted: 20.5.46.

Improvements relating to Apparatus for Heating Insulating Material by subjecting it to a High Frequency Field of Electric Force. J. C. Quayle and P. Jones. To: British Insulated Cables, Ltd.

Method of dielectric heating by means of high-frequency fields between metal electrodes which have a facing of non-cellular polyvinyl chloride. The facing prevents rapid cooling of the material to be heated due to contact with the cold electrode surfaces. In addition, the polyvinyl chloride contributes to the heat generated due to its high dielectric loss value. The facing is approximately 0.18 inch thick and is attached to the electrode by a suitable adhesive.

B.P. 577,526. Application date: 18.1.40. Convention dates (Holland): 21.1.39 and 23.12.39. Accepted: 22.5.46.

Process of Manufacturing Fibres, Filaments, Threads, Films and the like from Solutions of Proteins, especially Casein. Co-operative Condensfabriek " Friesland."

Fibres, filaments and the like produced by spinning alkaline solutions of casein into an acid bath. The protein solution contains less than .1 mol. of free alkali per kilogram of protein, and may also contain substances which are not alkaline or only weakly alkaline (i.e., urea, thio-urea), but which are capable of dissolving unneutralized protein. The protein solution is heated to a temperature above 80 degrees C. prior to filtration. Preservatives are added to prevent the growth of bacteria. Alternatively, the solution may be sterilized.

B.P. 577,561. Application dates: 21.3.43 and 24.1.44. Accepted: 23.5.46.

Phenol-Formaldehyde Resins. W. Charlton, J. B. Harrison and L. U. Perrins. To: Imperial Chemical Industries, Ltd.

Manufacture of phenol-formaldehyde resins and oil-soluble resins from ortho-cresol and para-hydroxy diphenyl in particular, by heating a mixture of ortho-cresol with para-hydroxy di-phenyl or ortho-hydroxy di-phenyl with aqueous formaldehyde in the presence of a strongly alkaline catalyst (caustic soda) until the resole separates from the aqueous layer, removing the resole from this layer and heating it under dehydrating conditions. These resins can be blended with drying oil to give varnishes which dry quickly and form films of excellent durability and resistance to water, acids and alkalis.

B.P. 577,562. Application date: 7.4.43. Accepted: 23.5.46.

Improvement in or relating to the Treatment of Cellulosic Pulp to reduce its viscosity characteristics. S. M. Edelstein.

The viscosity of cellulosic pulp may be lowered by warming a mixture of pulp and dilute hydrogen peroxide in contact with a metal selected from the group consisting of iron, copper, aluminium and manganese (stainless steel, manganese sulphate). In general, one part of hydrogen peroxide is sufficient for 100 parts of cellulosic pulp provided these metals are present. The pH of the mixture is kept between 6 and 8.

B.P. 577,569. Application date: 18.10.43. Accepted: 23.5.46.

Improvements in the Production of Laminated Fabrics. W. Kershaw, C. J. Whitelegg and G. W. Eisig. To: The Bleachers Association, Ltd.

Refers to laminated fabrics used for the manufacture of ground sheets, collars, cuffs, rainproof cloth, etc. The production of such laminated fabrics involves the use of an adhesive between adjacent fabric faces. This adhesive consists of an aqueous emulsion of polyvinyl paste which is first dried to effect a union between the fabrics and is subsequently gelatinized by heating. The polyvinyl paste consists of polyvinyl acetate dispersed in tri-cresyl phosphate.

B.P. 577,626. Application date: 12.6.44. Convention date (U.S.A.): 10.6.43. Accepted: 24.5.46.

Improvements in or relating to Solutions of Synthetic Linear Polyamides. To: Imperial Chemical Industries, Ltd.

Process for coating surfaces of wire or fabrics by applying compositions such as solutions of synthetic linear polyamides in 2-nitro 1-butanol and in particular solutions of polyhexamethylene adipamide or an interpolymer of polyhexamethylene adipamide and hexamethylene sebacamide in 2-nitro 1-butanol.

B.P. 577,629. Application date: 23.6.44. Convention date (U.S.A.): 23.6.43. Accepted: 24.5.46.

Improvement in the Manufacture of Rubber. To: Imperial Chemical Industries, Ltd.

Relates to the preservation of rubbers and in particular to improvements with regard to resistance of such rubbers to deterioration at high temperatures, by incorporating into the rubber mix a mixture of a member of the group consisting of N:N^1—diphenylbenzidine and C-substituted N:N^1—diphenylbenzidine and a secondary aromatic amine devoid of highly polar groups (phenyl-beta-naphthyl-amine).

B.P. 577,632. Application date: 13.7.44. Convention date (U.S.A.): 13.7.43. Accepted: 24.5.46.

Improvements in or relating to the purification of Alkyl Methacrylates. E. I. Du Pont de Nemours and Co.

Refers to the purification of alkyl methacrylate monomers obtained by thermal depolymerization, and in particular to methyl methacrylate. It comprises heating of the polymer to a temperature above its decomposition point, condensing the resulting monomer vapours and treating the condensed monomer with chlorine and subsequent distillation of the monomer so treated.

B.P. 577,640. Application date: 15.3.44. Accepted: 27.5.46.

Bonding of Rubber to Metal or other Rigid Components. C. M. Blow. To: John Bull Rubber Co., Ltd., and Metalastik, Ltd.

Improved bonding of rubber to metal for vulcanizing is achieved by treatment with esters of long-chain fatty acids with relatively high boiling points (cyclohexanol-stearate or methylcyclohexanolstearate). These esters improve the wetting of the surface and may be used in conjunction with a rubber solution containing zinc naphthenate which is applied over the ester film.

B.P. 577,657. Application date: 20.4.44. Convention date (U.S.A.): 24.4.43. Accepted: 27.5.46.

Improvements in or relating to the Manufacture of Regenerated Cellulose Sheets, Films, Filament, Threads and the like, produced from Viscose. British Cellophane, Ltd.

B.P. 577,676. Application dates: 15.12.43 and 18.10.44. Accepted: 28.5.46.

Improvements in or relating to the Production of Reinforced Plastic Articles. H. C. Martin. To: The Bristol Aeroplane Co., Ltd.

Reinforced articles from plastic materials produced by shaping in a mould under heat and pressure. The laminated material to be formed contains a phenolic or cresylic resin in the fusible stage. The moulding operation is performed at elevated temperature and provisions are made to allow for the escape of vapours from the mould.

B.P. 577,702. Application date: 7.7.44. Convention date (U.S.A.): 18.11.43. Accepted: 28.5.46.

Improvements in Methods of Bonding Rubber to Metal. To: United States Rubber Co.

Method of bonding rubber to metal by heating the metal with steam to a temperature above 212 degrees F., and subjecting to a pressure between 50 and 150 lb./sq. in., applying the rubber to the metal so treated and vulcanizing.

B.P. 577,708. Application dates: 29.2.44 and 31.5.44. Accepted: 29.5.46.

Improvements in the Cooling of Articles of Synthetic Rubber and like Moulded Material. G. R. Bates, Ltd.

The extruded or moulded material (synthetic or natural rubber, polyvinyl chloride and the like) is passed through a refrigerating chamber maintained at a temperature below 0 degrees C. Details of the apparatus used are given.

B.P. 577,718. Application date: 14.4.44. Convention date (U.S.A.): 16.4.43. Accepted: 29.5.46.

Process for the Production of Coloured Artificial Filaments of High Tenacity. British Celanese, Ltd.

B.P. 577,719. Application date: 22.4.44. Accepted: 29.5.46.

Improvements relating to Apparatus for heating Insulating Material by subjecting it to a High-frequency Field of Electric Force. J. C. Quayle and P. Jones. To: British Insulated Cables, Ltd. (See also B.P. 577,474.)

Refers to electrodes for high-frequency heating, faced with a high-loss heat-stable insulating material of cellular form, consisting of porous synthetic cordierite (a double

silicate of magnesium and aluminium). Alternatively, this facing may be of a foamed resin of the phenol-, cresol-, melamine- or urea-formaldehyde type. Another alternative is foamed polyvinylidene chloride.

B.P. 577,720. Application date: 22.4.44. Accepted: 29.5.46.

Improvements relating to Apparatus for Heating Insulating Material by subjecting it to a High-frequency Field of Electric Force. J. C. Quayle and P. Jones. To: British Insulated Cables, Ltd. (See also B.P. 577,719.)

Electrodes for welding or moulding insulating materials, the electrodes having a composite facing of an inner layer of high-loss inorganic insulating material of fibrous structure and an outer layer of high-loss heat stable insulating material of non-fibrous structure. The inner layer may consist of a felted fabric of glass, asbestos or slag wool and the outer layer of a resin of the phenol-, cresol-, melamine- or urea-formaldehdye type.

B.P. 577,735. Application date: 23.11.44. Convention date (U.S.A.): 23.11.44. Accepted: 29.5.46.

New and Useful Materials derived from Ethylene Urea. To: Imperial Chemical Industries, Ltd.

By reacting ethyl urea with formaldehyde in the presence of a basic catalyst in order to obtain N-hydroxymethylethylene-urea, which is subsequently reacted with alcohol in the presence of a catalyst. These materials may be used for crease-proofing.

B.P. 577,749. Application date: 19.2.43. Accepted: 30.5.46.

Improvements in and relating to the Polymerization of Linear Formals and Esters thereof. To: Imperial Chemical Industries, Ltd.

B.P. 577,752. Application date: 22.10.43. Convention date (U.S.A.): 30.10.42. Accepted: 30.5.46.

Improvements in and relating to adhesive coated fabrics. D. J. Buckley and R. L. Smith. To: Johnson and Johnson, Ltd.

Adhesive material with a flexible woven fabric backing, a pressure-sensitive adhesive and an intermediate barrier coat of film consisting of polyisobutylene, and a filler.

B.P. 577,753. Application date: 10.11.43. Accepted: 30.5.46.

Improvements in and relating to the Water-proofing of Casein Formaldehyde Plastics. J. B. Speakman and J. L. Stoves. To: Erinoid, Ltd.

Casein formaldehyde plastics are treated with a solution of soluble quinones (benzoquinone), or with tannic acid. The solutions contain a solvent which will cause the protein particles to swell and which consist of water, ethyl alcohol, methyl alcohol, or mixtures of the two. The plastics are boiled in these solutions or immersed at a lower temperature for a prolonged time.

B.P. 577,761. Application date: 21.4.44. Convention date (U.S.A.): 21.4.43. Accepted: 30.5.46.

New and improved plasticized compositions comprising Polyvinyl Alcohol. To: Imperial Chemical Industries, Ltd.

A plasticized composition consisting of a polyvinyl alcohol and a plasticizer being an aldehyde, and an alcohol which is not an unsubstituted monohydric alcohol, i.e., benzaldehyde, furfural, glycerol, ethanol formamide, etc.

B.P. 577,771. Application date: 20.11.44. Accepted: 30.5.46.

New Polymeric Substances. E. Isaacs and H. Gudgeon. To: Imperial Chemical Industries, Ltd.

Polymeric substances derived from alpha-acetaminoacrylic acid by polymerizing esters of alpho-acetaminoacrylic acid alone or together with other polymerizable unsaturated substances. These polymers are useful as thinning agents, as stabilizers for natural and synthetic latices, and also in the manufacture of photographic materials, etc.

B.P. 577,790. Application dates: 29.8.38 and 31.10.38. Accepted: 31.5.46.

Improvements relating to the Manufacture of Light Non-metallic Structural Material or Components. N. A. de Bruyne. To: Aero Research, Ltd., and de Havilland Aircraft Co., Ltd.

Manufacture of reinforced synthetic resin structures in cellular form used for the production of simple structures (boards) which may be used as such or can be cut into panels or the like to build up more-complex structures. The method of manufacture consists of the following steps: taking unset resin-impregnated fibres or filar material and wrapping it continuously over a series of cores which are packed parallel but separated by the material, applying heat to the entire pack and applying pressure transversely to the cores, withdrawing the cores from the material so that a reinforced cellular structure is left. Detailed drawings to explain the method are given.

Planned Mould Maintenance Service Aids Economical Production

Section XX (contd.)

By W. M. HALLIDAY

In the first portion of this article dealing with the hand-operated feed drum mechanism various useful suggestions were offered for ensuring that wear, errors, and misalignments be maintained at the minimum, and the maintenance service of the simplest kind. All those points apply equally to the mechanism here illustrated and described, since the mould construction is substantially the same.

IN order to prevent undue spring and wear the fulcrum stud for the combined helical gear wheel and spur pinion in engagement with the rack, should be made very ample in proportions and also securely fixed to the base block. Preferably these should be very accurately machine-cut gears, and the bore should be lined with a bearing sleeve made from some of the well-known anti-friction metal. Adequate provisions should be made for applying lubricant to these gears.

The operating rack likewise should slide within a specially hardened and lapped bushing tightly driven into housing hole in extension block. This will enable the rack to be kept a very close working fit and therefore correctly in mesh with the pinion.

It will be realized that no large amount of play is possible between the rack teeth and those of the pinion, or indeed between any of the gears in mesh, since this would in time lead to a shortage of travel of the feed drum and consequent incorrect alignment with the insert seatings holes.

As will be seen, this mechanism for obtaining automatic rotation of the feed drum, etc., is extremely simple and allows very free access to all important parts, thereby greatly facilitating inspection, test, cleaning and adjustment by the maintenance engineer, without having to dismantle portions of the mechanism. In order to keep out dirt, moisture and particles of powder it would be advisable to fit a suitable sheet-steel cover over this gear mechanism which would totally exclude all such injurious matter, yet at the same time permit ready accessibility.

This mechanism is really so simple and foolproof that little should go amiss given a sufficiently strong construction and periodic attention as regards cleaning, lubricating and slight adjusting.

There is one feature worthy of note, since in certain mould constructions this may prove a disadvantage. This relates to the return or closing movement of the mould blocks and the action of the gears. As will be understood when the movable block moves inwards after the feed drum has been loaded in the manner already described, the compression spring f will exert pressure upon the operating rack to force this member out of its housing, thereby rotating the gears and the feed drums through one full revolution in the reverse direction to that imparted during the loading cycle. This may prove unsatisfactory on some mould layouts.

It may easily be overcome, however, by a slight modification to the gearing in the following manner: Instead of the small pinion d attached to the gear wheel b there should be a ratchet-toothed wheel. The stud c should then be made long enough to take a pawl-carrying-block, whose periphery should be provided with spur teeth for engagement with the rack e. Into this pawl block a number of pawls for meshing with the ratchet should be installed, these being situated upon fulcrums, so that they are free to move in and out of mesh easily. Each one would be held in mesh by means of a stiff spring.

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Compressive Strength (lb./sq. in.)	65,000	34,000	42,000
Shear Strength (lb./sq. in.)	18,000	11,000	15,000
Cross-breaking St'gth (lb./sq. in.)	29,000	14,000	19,000
Impact Strength (ft./lb.)	5	2.5	4
Fatigue Strength (tons/sq. in.)	3.75	1.0	2.25
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The pawl block would then be bored out centrally, so as to be a free running fit over the extended portion of fulcrum stud, and a collar would be fastened to the end portion of the fulcrum stud to restrain the pawl block from passing too far out of endwise relationship with the ratchet gear wheel.

If this ratchet wheel is provided with an odd number of teeth, and those of a fine pitch for preference, and say four or even six engaging pawls, each of identical length from centre of fulcrum hole to tip, the amount of lost movement before one pawl made engagement with the ratchet would be restricted to not more than one-quarter or one-sixth of the pitch of the ratchet teeth. Of course, only one pawl would make engagement with the gear at any given time, the purpose of the others being solely to ensure the smallest amount of free movement. This is a very satisfactory and inexpensive ratchet drive, which is both positive, clear of undue lost motion and reliable. It ensures practically immediate pick-up between the rack and the driven pinion Y, and so similar instantaneous operation of the feed drums, etc.

By the introduction of such a type of ratchet drive, the feature of the spring returning the operating rack during the closing stroke of mould block would be completely eliminated, since the rack would be carried back again to its extended position, but this movement would not produce any movement on the feed drum, since the pawls would simply slip over the ratchet teeth.

Automatic Drum Feed for Inserts in Inclined Locations

In point of fact, this is a method frequently employed by the writer for obtaining motions of this character, but since it constitutes one of the best known of mechanical means for obtaining single direction motion, it is not deemed necessary to illustrate same in connection with the mould design just considered.

The next example of drum-type feeding of inserts will be found especially interesting, and, it is hoped, useful in guiding designers and mould engineers, because it shows a very simple form of mechanism incorporated in an injection mould for automatically feeding cylindrically shaped insert components to a multi-impression injection mould, where it was necessary to locate eight of these parts at a slight angle within the single large mould cavity, as is shown in the section view of the movable block and associated mechanism.

As readers will doubtless be aware, the positioning of inserts at an angle within a mould cavity instead of at right angles to the parting line surface often entails considerable trouble, and, therefore, the following example will be found helpful.

It will also be seen later that the method employed for automatically operating the feed drum, etc., whilst derived from the opening motions of the movable block, is somewhat different from that dealt with in respect of the design illustrated in the July issue. In this present instance a cam plate is used, thus ensuring a very positive and easily adjusted form of movement.

Construction of Insert Feeding Mechanism

As just intimated, the particular problem in connection with this injection lay in effectively feeding eight insert pieces, made from brass rod, to the eight seatings provided at the base of the large circular cavity shown in Fig. 1. The angle of inclination of each insert had to be eight degrees above the longitudinal axis of block, and each insert when moulded-in was required to project for about half its length beyond the top face of the component.

Owing to the large number of inserts involved and the high rate of production, it was considered advisable to develop some purely mechanical means for feeding these parts with precision and reliability to a degree not possible with manual placing of the inserts.

Because of the configuration of the cavity, etc., it was necessary to feed these insert parts from the rear of the movable block.

Referring now to the sectional view of

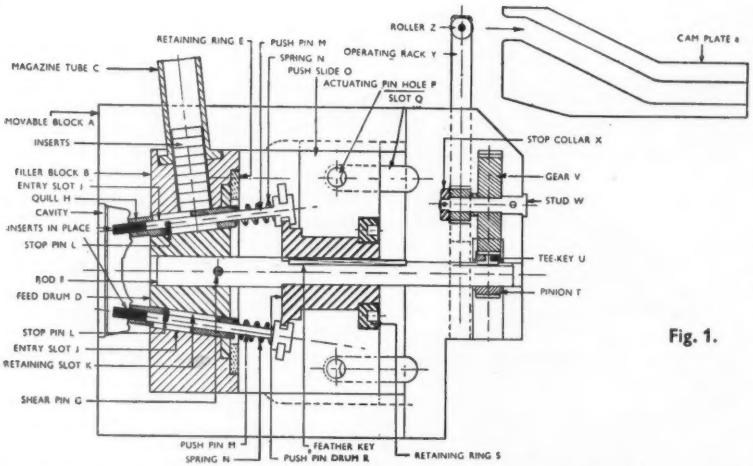

Fig. 1.

the movable block and all the automatic mechanism shown in Fig. 1, it will be observed that the block A is made of very substantial thickness so as to allow it to be cut out fairly extensively from its rear side in order to receive the block piece B. This latter is rectangular in shape and made of ample proportions so as to withstand easily any tendencies to distortion or flexing. This member is secured down positively and permanently by any convenient means, but provision should be made for its occasional removal as will be required for cleaning and renewal of worn portions from time to time.

The Feed Drum

To the top edge of this block is then affixed permanently the magazine tube C whose interior shape and dimensions conform easily to the shape of the insert being handled by the mechanism. The portion of block B immediately underneath the end of this magazine is similarly slotted for a certain distance as will become clear later.

This block is bored out centrally with a tapered hole the angle of inclination of the sides thereof being identical with that at which the inserts have to be inclined within the cavity, i.e., 8 degrees in this present case. Fitted into this tapered hole is the feed drum D, it being provided with an enlarged flanged portion at its right-hand side which is fitted freely within a shallow recess cut in the end face of block B as indicated. The brass retaining ring E is secured positively to the end face of B by small countersunk screws not shown, these serving to maintain the drum correctly located within the block permitting it only to revolve.

The drum itself is bored out centrally to allow the operating rod F to pass within easily, and both members are then firmly connected together by the small-diameter shear pin G passing through both, and whose purpose is to act as a safeguard against overloading the mechanism at this point in the manner already described in reference to an earlier design.

The left-hand end face of the feed drum will be noticed as being exactly flush with the endface of the block B where it bears against the wall of recess cut in the block A. This is an important provision since any gap here would be liable to become filled with excess plastic material, dirt, or oil residues, and would be somewhat difficult to remove without extracting the entire block assembly from the movable block.

No doubt the method employed for

holding and feeding the inserts into position will prove extremely interesting as this embraces a most unusual form of construction.

The feed drum D is fitted with eight hollow quills as at H, each of which is a sliding fit within the bored hole provided for it at an angle through the drum. The internal-bore diameter of each quill is just large enough to allow an insert to be pushed through, and the bore pins, to be described later, are also a sliding fit within this bore.

The Insert-holding Quills

The front portion of each quill is reduced slightly in diameter for a short distance so as to be a light press fit within the hole between base of mould cavity and junction of feed drum left-hand face with the wall of movable block. The length of this reduced part should be carefully controlled so that the step formed on quill serves as a positive end stop to prevent the quill from being pushed too far into the mould cavity.

As will be realized from the foregoing, the extreme left-hand end face of each quill is thus made to stop off the cavity immediately surrounding each insert, and on the actual mould these quills were allowed to project into the cavity area 1/64th in. so as to mould a shallow recess around the insert member when completed.

Into one side of each quill is machined the entry slot J wide and long enough to allow an insert component to fall very easily into the bore of quill. The position along the length of quill for this slot is determined by the location of magazine tube C and the extent of the withdrawing movement imparted to the quills as will be understood later.

Push-pin Mechanism

A second slot K is machined in each quill member immediately opposite to the slot J, but this retaining slot is made somewhat longer and only wide enough to allow free sliding movement to the stop pin L shown in solid black shading.

This stop pin is a tight fit into a hole drilled cross-wise in the appropriate lengthwise position in the push pin M which is made a free sliding fit within the bore of the quill.

Each push pin is provided with an enlarged head portion at its right-hand end, this head being deeply grooved at each side by milling two slots partially through head diametrically opposed. The solid portion of the head remaining at base of slots should be made with perfectly flat faces and exactly parallel as these are employed for sliding within the slotted portion of the push-pin drum.

A suitable coil spring N is located around each push pin between its head and the right-hand end of the quill member in order to hold this latter always in an extended position as shown in the sketch, which illustrates the positions of those parts when the mould is in its closed stage in readiness for an injection shot. These springs force the quills right up against the edge of hole in block A, thus affording effective sealage against plastic material being injected into the inner mechanism.

The end portion of the recess in the movable block A is machined to form suitable dovetail guideways to receive the push-pin slide O, this being actuated by a pair of pins set at an inclination from the parting-line surface of the stationary block and engaging with holes P, a clearance slot Q being machined at each point behind the slide to afford freedom of movement for the inclined pins.

This slide O is bored out centrally with a parallel hole into which is fitted the push-pin drum R. The left-hand portion of this latter member is provided with an integral large flange, whilst the other end is reduced slightly in diameter for a short distance and externally threaded to receive the retaining ring S, whereby when this ring is securely screwed in position on the drum, by means of a series of tommy-pin holes provided for the purpose, all endwise movement other than working clearance is restricted, yet the drum is left free to rotate within the slide.

The eight push pins M are connected

to the drum R as follows: The large left-hand flange of the latter member is made just thick enough to allow it to pass within the groove cut around the pin head. Then eight radial slots are cut in the flange for a certain depth, these being wide enough to permit the squared or rectangular solid portion at bottom of groove to slide freely.

Thus in this manner each push pin will travel with the drum when the latter is moving horizontally, due to actuation of the push-pin slide, but since each pin is free to slide outwards or inwards as the case may be across the flange portion of drum, these will be withdrawn easily from the inclined holes in the feed drum. In the positions indicated, when the movable block is in its closed situation the head portion of the push pins is occupying its innermost location in relation to the flange. When the push-pin slide is withdrawn the push pins will gradually take up a widening position in respect to the flange.

It will be appreciated that by this method of pin engagement with its drum the former are allowed to slide only, all rotating motion being entirely restricted by reason of the form of connection with the head of pin. Because of this the quills in like manner can only slide within the holes in the feed drum since the stop pin L fastened to the sliding push pin normally engages the sides of the parallel elongated slot K in the quills.

The push-pin drum is also bored out centrally to be a sliding fit over the reduced portion of the rod F, a parallel keyway being provided for engagement with a long feather key fixed to shaft, whereby the drum is free to slide only, all turning movement of the shaft being immediately transmitted to the drum and thence to the push pins, quills, etc.

Rack and Cam Mechanism

Here, again, is a most unusual, and it is hoped, interesting application of a combined rack and cam mechanism for obtaining the requisite actuation of the arrangement already described from the normal opening movements of the mould block A, and with simple modifications the construction is one capable of numerous useful applications.

The operating rod F is extended well beyond the right-hand side of the push-pin drum as shown. To an ample sectioned extension block affixed permanently to the rear of the movable block a bearing is provided through which the rod F is free to pass. This bearing is slotted out in the centre to admit the small steel spur-toothed pinion T. To this latter member is secured the tee-shaped key U, which, in its turn, engages the parallel keyway cut along the rod F from its right-hand end for a specified distance. This provision allows the rod to slide within the pinion freely, but at all points any rotation of the gear will be immediately transmitted to the rod and rest of mould mechanism connected thereto.

Also contained in the extension bearing block is the dual spur gear V, the larger member of which meshes directly into the pinion T. As will be seen, the ratio of size of these two components is about 2 to 1. This dual gear is made a free revolving fit upon the stationary stud W fastened to the bearing housing in the manner shown. The left-hand end of this stud is reduced in diameter for a small distance along part to take the stop collar X, which is pinned firmly in place.

Operation of the Mechanism

The operating toothed rack Y is located in a suitable vertical housing, consisting simply of a bored hole passing through the bearing extension block, since the rack is cylindrical with teeth cut into one side only, and engagement with the small gear on gear V prevents rotation within bearing.

To the topmost end of this rack is affixed a rotatable roller Z by means of the fixed fulcrum pin passing through both members in the manner shown. This roller is, of course, hardened and well polished and the outside diameter is

made a free running fit within the shaped track of the cam plate as shown to the right-hand side.

This cam plate track is attached securely to the machine tie bars, or tie bar end casting, and so arranged in the contour of the roller track to give the required degree of vertical travel to the operating rack necessary to impart the same to the feed drum, etc.

Here, again, the method of functioning of this mechanism is extremely simple and, of course, fully automatic. When an injection shot has been made, the blocks are opened in the usual manner, which causes the push pin slide to be retracted within its guideways. This action first results in the push pins M being pulled out of the quills, these latter remaining stationary until the stop pins L have traversed across the elongated slots K. Immediately this has been accomplished and the pins bear against the right-hand side of the slots, the quills are drawn outwards for the remainder of the travel of the push pins. This is sufficient to extract the reduced end of quill from the hole in the movable block located between cavity base and wall against which the block B is situated.

At this point the ejectors, which are not shown in the illustration, are brought into operation to push the finished moulding out of the cavity. This, of course, is rendered possible since the angularly disposed quills have been withdrawn sufficient to give clearance to the projecting portions of the moulded-in insert components.

Further opening movement of the block causes the roller Z to pass into the cam plate track, thereby pushing the operating rack downwards at a slow speed. By this means the operating rod F is slowly rotated. As the feed drum is connected to the same rod F this also rotates in unison with the other parts, and the entry slots in the quills now being drawn back so as to lie exactly underneath the opening of the magazine, insert components fall by their own weight one into each slot as the feed drum slowly revolves past that point.

The gears and cam plate are so predetermined as to secure one complete revolution to the feed drum, thus enabling all eight loading points in that member to pass the magazine. When fully loaded and the mould block has been withdrawn the maximum amount immediate commencement of the return stroke may be made, which will first lift up the operating rack back to its previous position as shown in Fig. 1 in readiness for the next loading cycle, and also cause the push pins to be carried within the quills, which latter are also returned to their correct moulding position. Passage of the push pins within the quills causes the insert components to be carried forward so as to project the required distance into cavity area.

When the quills have been carried almost to their closed position the outlet from the magazine tube becomes stopped off by the solid wall of the quill as shown in Fig. 1, so that further inserts cannot fall down into quill bores until these have been emptied after the injection shot, and withdrawn the required distance.

In order to facilitate the feeding of the inserts into the feed drum slots the magazine tube is inclined at 8 degrees so as to bring it square to the line of inclination of the inserts.

Summarized Advantages of Design

Since this construction embodies design features of such an unusual character yet of wide application, it will be well worth while to enumerate a few of the practical advantages to be gained from its use.

(1) This design permits fully automatic feeding of inserts even when these have inclinations, where hand feeding would be both troublous and protracted.

(2) By slight modifications to the feed drum shape and layout it is possible to feed inserts into the same cavity, or a number of cavities, even when the component to be moulded-in has to be located at a different angle from its neighbour. All that would be required to accomplish these ends would be to make

the conical shank of the feed drum to suit the steepest angle of insert location, and then to machine the seatings for all other inserts with the base portion at the necessary different angle so that the inserts would fall into the correct line. The push pin holes would also have to be drilled at appropriate angles to suit.

Even in such circumstances the push pin connection to the slide would permit ready operation of such a set of differently inclined pins.

(3) By adjusting the length of the push pins it is easily possible to use the device for handling inserts of different lengths within the same cavity, or alternatively for positioning the inserts within the cavity area so as to obtain greater or smaller degrees of projection when finally moulded in place.

This is a great help in many instances when the length of projection of the finished pin must be different in each case.

(4) The mechanism is entirely automatic and positive, always ensuring that the feed drum has been traversed through one complete revolution. The only varying factor will be the speed of revolution imparted to the drum. In cases where the movable block is opened at a rapid rate, then the speed of rotation of the feed drum will be commensurately quickened. The writer has found that a drum speed of approximately 20 r.p.m. is usually ample to ensure ready loading. Of course, where the number of inserts to be loaded per cycle is extremely large, necessitating very small gaps between one seating and the next in the shank of the feed drum, it will be necessary to instal an intermittent one-way circular motion to the feed drum. This may be obtained very simply along the lines suggested in last month's published portion of this section.

(5) In one application of this design made by the author the quills were made of spring steel and suitably tempered, and the front end portion was slotted into the bore at three points in order to impart a degree of springiness to the tube. The reduced portion at extreme front end was made conical on the exterior and the hole bridging the cavity with the fixed block B made similarly tapered.

The purpose of this adaptation was to ensure that a certain amount of frictional grip was imposed upon the inserts when in position within the cavity to obviate all tendency of their moving out of position due to vibration of the closing mould blocks, etc. As the quills reach their closed position slightly before the mould blocks become fully closed, the tapered slotted ends of the quills are forced into the tapered seats, resulting in a slight closing in of the walls of the former member, sufficient to secure a smart grip upon the insert component passed into place within the quill. This was found extremely useful on fast working moulds, or where the insert parts were heavy in weight.

(6) By employing a cam plate and a geared drive to the feed drum it is possible very conveniently to locate the drive in relation to the mould block. In cases where other parts of the mechanism forbid closely situated drum drive, the rod F is simply extended and the bearing block for the gears carried farther back as desired.

(7) By using the slotted cam plate with the double-sided track that is, positive movement is assured on both the working and return stroke, thereby obviating the need for return springs, or other devices, to the operating rack. This is automatically returned by the cam to its starting position.

(8) All the mechanism is quite accessible, rendering cleaning, oiling, and adjusting operations extremely simple and convenient. Should any tightening occur at any point the shear pin through rod F and the feed drum will break, thereby preventing serious injury to the parts and thus warn the operator that the mould needs attention.

Maintenance Requirements

Whilst the degree of maintenance attention entailed in keeping this mould construction working in the most efficient manner should normally be very small,

it will be advisable very briefly to mention a few items in reference to which very worth-while improvements can be effected to the construction. The author has confined himself in the illustration here shown to depict the basic principles and methods of the design and construction of the mould for the sake of clarity The points to be noted are as follows:—

(A) The actuating pin holes in the slide O should be provided with hardened renewable bushings of the type previously described because any wear between these holes and the pins working therein will cause the inserts to be carried short of their correct location in cavity, and in addition may entail some trouble with respect to the entry slots matching up correctly with the outlet orifice of the magazine. This in turn would cause jamming or sticking of the inserts instead of freedom to fall easily into place by their own weight.

(B) It would also be essential to have some means for maintaining the close fit between the slide O and its guideways, because again any wobble or undue slackness here would result in faulty indexing of the feed drum and consequent failure of the inserts to fall into their respective seatings.

(C) The writer would also urge the necessity for very careful fitting of the bearing holes for the stud W to ensure that the meshing of the gear teeth is accomplished with an absence of play. It will be preferable to make a separate bracket or block carrying this stud so that final accurate adjustments for tooth engagement may be made on the assembled mechanism. The gears, too, should be hardened and the combined wheel V provided with a renewable bearing bushing to counteract wear between its bore and the stud. It should be borne in mind that these parts are not subjected to any heavy load, but are required to operate accurately and smoothly.

(D) If desired, the stop step on the sliding quills could be moved backwards to the extreme right-hand end of the part, this being enlarged in diameter so that the step can bear against the right-hand end face of the drum. The great advantage in this alteration is that any dirt, oil, or extraneous particles can be more readily discerned and extracted than in the kind illustrated. By this means the maintenance engineer would spare himself frequent dismantling of the mould for necessary cleaning.

(E) Care will also have to be taken of the stop pins L which engage in the elongated slots in the quills, because should one of these break or become bruised and tightened in the slot the quill may rotate and so get out of true location, or fail to move at all. Where very extensive runs are to be provided for, it would be advisable to have more substantial means for keying these two members together and therefore it would perhaps be necessary to fit the push pin with a small feather key, and the bore of each quill to have a keyway into which the key would be made a sliding fit.

(F) The head portion of the push pins should also be very accurately made and fitted to the slotted flange of the push slide drum, so that no undue play develops between these members. Preferably the heads should be hardened, and during operating any binding tendencies noticed should be immediately investigated. If it was wished absolutely to ensure against the ill-effects of wear, etc., the head portion of the pins could be modified in the following manner: Instead of slotting in the way described, the head could be made Tee-shaped, with a squared portion to fit the slots in the flange of drum as before. A small cylindrical and threaded extension piece would then be left, to which could be secured a stiff check plate in hardened steel, this being locked in place by a small nut. Thus, in the event of wear, all that would be required would be to adjust the nut, so as to close the plate inwards a slight amount, thus narrowing the gap bridging the flange of drum. This modification enables the maintenance engineer to keep a very close smooth fit between these parts, and is well worth adopting.

Conclusions

Although these various designs by no means exhaust the number of interesting types of automatic drum-type insert feeds which could be presented, perhaps enough has been shown to illustrate the many useful applications which may be made to seemingly difficult feeding problems, and, therefore, in the next section the author proposes to deal with a number of very unusual mould designs, admittedly of somewhat more limited application than those already dealt with.

However, in spite of that, these designs and mould constructions will indicate useful ways in which insert feeding difficulties may be overcome, and thus perhaps serve as some guide to the designer or toolmaker in evolving satisfactory constructions.

Following that, when, of course, stress will be laid upon the maintenance services involved and the best designs and constructional methods for reducing such attention, the author will devote some space to the illustration and discussion of the merits, etc., of a number of useful toolroom auxiliaries and tools which have been specially useful for facilitating inspection, checking, cleaning and repair operations on injection and compression moulds.

As many readers will doubtless have realized from their own practical experiences in mould maintenance, a great deal depends upon the facilities available for handling moulds during alteration and correction, and in this connection the writer will indicate a number of useful devices which he has developed in mould manufacture and maintenance.

As was remarked at the outset of this series, a great deal depends upon the methods employed for successfully organizing mould maintenance if production is to be kept at the maximum scale, and when we come to the study of these aids to the maintenance toolmaker, special attention will be given to methods and preferred practice.

(To be continued.)

Swedish Plastics Federation

IN order to take care of the interests of the Swedish plastics industry, an association was formed at the beginning of the war. This association, originally founded to act as a council for questions on imports, raw materials, distribution of supplies, etc., was called Svenska Konsthartsindustriens Ravaru-och Import Förening (SKRIF). Extensive investigations were commenced, which will result in various standards.

The original purpose of SKRIF was to take care of the interests of its members with regard to special conditions existing during the war. After the conclusion of the war, when most Government restrictions ceased, the principal need for the existence of SKRIF disappeared, and it was therefore decided to liquidate this association.

As a consequence of expansion during the war, the members of the dissolved association found it desirable to establish a branch organization to take care of common interests. The Svenska Konsthartsföreningen —The Swedish Plastics Federation (SPF)— was therefore founded in February, 1946, by about 80 companies representing manufacturers and suppliers of raw materials, synthetic resins and glues, moulding powders, laminated materials, machinery, and moulds.

The aims of SPF, briefly summarized, are to work for a general raising of the technical standard of the industry, better co-operation between the various groups of companies, increased and reliable information about different plastics and their use, and standardization and nomenclature in the plastics field. In order to study and supervise questions of special interest, the following committees have been established:—Publicity and public relations, literature questions, nomenclature, standardization, statistical questions, plastics materials, and moulders. The committee for plastic materials will have sub-committees dealing with synthetic resins and glues, thermosetting materials, and thermoplastic materials.

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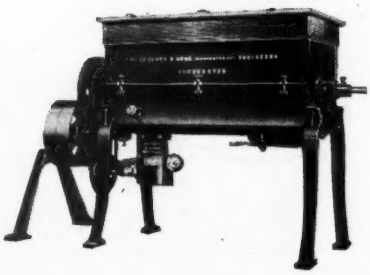

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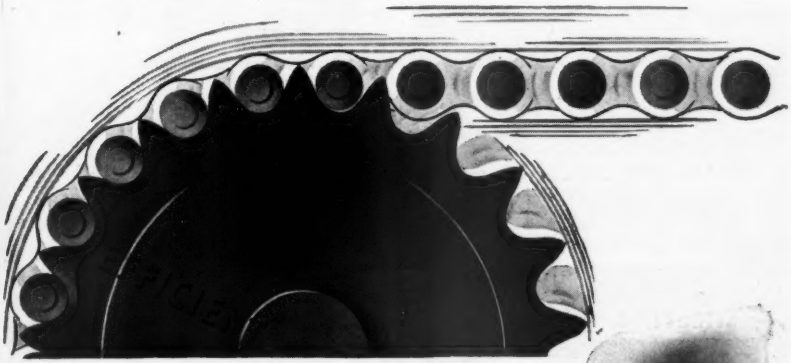

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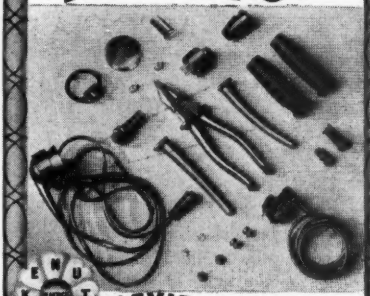

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THE DESIGN GROUP, LTD., can now accept assignments for the design of plastic products and components. Our production and tool-drawing office has a capacity of over 1,000 hrs. per week. Commonwealth House, W.C.1. Phone, Chancery 6451 (10 lines). 111–7073

HARDWOOD PEGS, good cut and quality, large tonnage available. Quotation by return. Box 3814, care of "Plastics." 111–2

AGENT, with office and stock room, callnig on wholesale and retail, seeks manufacturers of kitchen and household articles electrical and plastic ware, fancy goods, toys, haberdashery, smallware and hardware, stationery and imitation jewellery to represent on commission basis or on own account against cash, for home and export trade. Turner, 2, Sydner Road, London, N.16. 111–7

PERSPEX STRIP, 12 ins. by 1 ins., in clear ⅛ in. or 3 mm., any quantity. Whiteman, 34, West Street, Bognor Regis. 111–8

TOOLMAKERS AND DESIGNS (COVENTRY), LTD., Brays Lane, Coventry. Capacity available for design and manufacture of moulding tools. 111–10

6–8 WEEKS DELIVERY all types plastic moulds, especially comb moulds for injection machines. Also intricate press tools. For export only, unless buyer can obtain import licence. Continental manufacture. Write, Uni-Artid Exports, Ltd., 175 Brompton Road, S.W.3. 111–14

NEW PLASTIC LINES and other fancy goods in domestic trades required by live manufacturers' agents. Box 3805, care of "Plastics." 111–17

A PLASTIC MOULDING COMPANY with own toolroom is interested in close association with mail-order house of repute, requiring big output in small Bakelite and Urea articles. Box 3806, care of "Plastics." 111–16

WANTED, one million plastic cups for export, to be supplied within next three months. Firms able to supply the whole or part order should write immediately to Quilliam Products, 22, High Street, Kingston-on-Thames. Phone, Kingston 3206, and Popesgrove 4622. Please let us have two samples of each cup and beaker you are at present producing, for which we will pay. Our relief from purchase tax number is Kingston 1–81. 111–20

LEADING MANUFACTURERS' AGENTS with country-wide sales representation, seek further lines suitable for toyshops, stationers, chemists and leather goods dealers. Commission basis. Write "Sales Force," 25a, Boundary Road, N.W.8. 111–23

Production Capacity Available and Wanted (contd.)

HERBERT DALES, industrial designers, undertake mould and moulding design, prototype machines and model maker, 7, The Parade, Leamington Spa. 111–21

WANTED, offers of clear glasslike Perspex sheets, all sizes and thicknesses, also offers of plastic beakers, plates, cups and saucers, cloth and made-up garments, belts, braces, bangles, etc., etc. We have over 1,500 important buying agents all over Hong Kong, Malaya, Burma, India, Ceylon, Egypt, East, West and South Africa, whose permanent orders are enormous. Quilliam Products, 22, High Street, Kingston-on-Thames. 111–27

LEADING FIRM in plastic sheeting, with constant supplies of plain and printed material, requires well-connected agents visiting manufacturers and makers-up. References essential. Box 3993, care of "Plastics." 111–30

LARGE QUANTITIES of first-grade P.V.C. sheeting, plain and printed, in exclusive designs, available from stock. Continuous deliveries, competitive prices. Special terms for contracts. Box 3994, care of "Plastics." 111–29

P.V.C. SHEETING, 3s. 6d. per yard, first-rate quality, also plain and printed. Also 40-thou. material. Apply Box 3992, care of "Plastics." 111–35

PLASTIC SIDE COMBS, 3½ ins. long, available for home market. Apply Box 3991, care of "Plastics." 111–34

PLASTIC EYESHIELDS available for immediate delivery. Ex-Government stock, 9s. per gross. Apply Box 3990, care of "Plastics." 111–33

PLASTIC FIRM with own moulds require moulding capacity up to 3-oz. shots. Reasonable runs. Good prices offered. Box 3798, care of "Plastics." 113–7654

WANTED TO PURCHASE, any quantities Bakelite, Urea and Phenol powders. Cash terms. Box 3812, care of "Plastics." 112–7655

ETHYLENE GLYCOL. Advertiser requires regular supplies of ethylene glycol for own consumption. Full particulars of tonnage available to Box 3813, care of "Plastics." 113–7656

MANUFACTURER requiring larger premises has immediate capacity for light drilling and assembly work, polishing and plating, W.3 area. Box 3980, care of "Plastics." 111–x9994

FIRM NEAR LONDON with first-class connection in the wholesale perfumery, cosmetics and soap-making trade, wish to contact well-placed manufacturers of plastic container for creation of new articles and with a view of securing sole agency for these particular trades only. Box 3841, care of "Plastics." 112–x9547

LARGE DISTRIBUTORS require all types of plastic lines. Large quantities taken. Anderson and Page, Ltd., 20 Fitzroy Square, W.1. 111–x9316

INJECTION MOULDING CAPACITY available up to 3½ oz. Also capacity for de-flashing, drilling and polishing, etc. Box 3427, care of "Plastics." 111–x7889

REPAIRERS

REED BROS. (ENGINEERING), LTD., report that the equipping of their Welding Department, at Albion Works, Alberta Street, Kennington, S.E.15, is now completed. They are accordingly in a position to undertake welding repairs, fabricating of machines, plant and structures to customers' requirements. Favourable delivery dates can be quoted at the present time. Enquiries should be addressed to Head Office, Bevis Marks House, London, E.C.3. Telephone: Avenue 1901/5. 111–25

SITUATIONS VACANT

MANAGER, storekeeper and order clerk wanted for plastic and photographic material business. Lloyd's, 72 Bridge Street, Christchurch. zzz–49

MANAGER to take complete charge medium-sized chemical works, a responsible position requiring very capable man. Box 3374, care of "Plastics." 111–7314

CHEMIST OR TECHNICIAN required, fully experienced in the handling and production of polymethyl methacrylate and its waste materials. Company, with plastic department, interested in further development of the above and other thermo-plastic materials, wishes to engage energetic man. Good prospects, permanent position. Applicants should state experience, age and salary required. Box 3371, care of "Plastics." 111–7313

CHEMIST (qualified) for research on plastics required by well-known manufacturers near London. Experience in organic and physical chemistry preferred, but not essential. Permanent and progressive position with good salary and excellent prospects. State particulars of education, past experience, age and salary required. Strictest confidence assured. Box 3987, care of "Plastics." 112–7666

Situations Vacant (contd.)

REPRESENTATIVES required to sell Perspex and plastic utility household articles in beautiful colours. Reply to Box 3804, care of " Plastics." 114–7660

FOREMAN MOULDER to take charge small moulding department (compression), Manchester district. Enclose full particulars previous employment and wage required. Box 4073, care of " Plastics." 113–7671

DRAUGHTSMAN (20–25) with experience in detailing compression and injection moulds, wanted by progressive firm of manufacturers. Knowledge of press-tool design desirable. Very good prospects for the right man. Apply Box 4068, care of " Plastics." 111–41

CHEMIST with experience of plastics required by large oil-proofing firm. Excellent prospects. Salary £500–£600 per annum. Box 3844, care of " Plastics." 111–x9492

MAN WITH INITIATIVE to take charge small plastics department. Compression, injection, fabrication, etc. Situated Birmingham. Able to control labour and develop ideas. Good prospects, conditions, pension, etc. Box 3796, care of " Plastics." 111–1

WANTED, young man, age 30–35, with experience in production of plastic goods for household use, who would be interested in supplying his technical knowledge in exchange for advertiser's capital in new project Liverpool area. Apply Box 3817, care of " Plastics." 111–4

WORKS MANAGER required for plastics (thermo-setting) moulding plant in London area. Excellent prospects for a young, energetic man with sound technical background. Write full details to Box L5706, A.K. Advg., 212a, Shaftesbury Avenue, W.C.2. 111–12

INJECTION MOULDING ENGINEER-DEMONSTRATOR required by manufacturers and importers of one of the best-known ranges of injection moulding machines. Applicants should be able to set up, demonstrate and service machines, advise on mould design, and preferable also be able to undertake at a later stage sales. This post offers very wide scope for the right type of man with experience and initiative. Apply Box 3801, care of " Plastics." 14–18

FIRST-CLASS REPRESENTATIVES required calling on drapers and general stores. Salary and commission or commission only. Write, " Sales Force," 25a, Boundary Road, N.W.8. 111–22

TECHNICAL REPRESENTATIVE with good engineering background and wide practical experience of phenolic plastics, including mouldings, moulding materials, synthetic resins cements, varnishes and lacquers, for the North-Western Area. Must have proved sales record and, preferably, be well established in the above area. Apply, giving full details of experience, salary, age, etc., to Messrs. Birkbys, Ltd., Liversedge, Yorks. 111–24

LACRINOID PRODUCTS, LTD., invite applications for post of General Works Manager for Canada. State fully academic and technical qualifications and industrial experience. All interviews by appointment. Strict confidence guaranteed. Apply, " G. W. M.," Lacrinoid Products, Ltd., Gidea Park, Essex. 111–31

FOREMAN REQUIRED by company interested in the manufacture of moulding powders and the handling of plastic materials generally. Applicant should have knowledge in the handling of thermo-plastic materials. Permanent positions. Good prospects. Applicants please write, stating age, experience and salary required, to Box 3800, care of " Plastics." 113–7658

JOURNALIST with specialized knowledge of plastics to contribute a monthly column dealing with the application of plastics to mass-production technique for a journal dealing with mass production which is not competitive with specialized journals of the plastics industry. Apply Sawell and Sons, Ltd., 4 Ludgate Circus, London, E.C.4. 113–7662

SITUATIONS WANTED

AS MANAGER, decorative laminated plastics. Preference establishment of new department. Comprehensive administrative experience, impeccable references. Box 3633, care of " Plastics." 111–x8896

MAN, age 37, 14 years experience plastics industry, practical and executive, desires situation works manager, assistant works manager. Any location, but West Country preferred. Box 3995, care of " Plastics." 111–28

JOB in which initiative, responsibility, tact, loyalty, concentrated effort essential required by young officer, 27 years old. Go anywhere. Initial salary unimportant providing good prospects. Reply Box 3988, care of " Plastics." 111–36

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P.V.C. SHEETING, 1st and 2nd qualities, wanted by Manufacturer of Plastic Aprons, etc. Samples and lowest price to the Blackburn Plastic Co., Ltd., 6, King Street, Blackburn. 111–x9898

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PLASTIC TRANSPARENT SHEETING wanted, .005, .006 thickness, all colours. Box 3780, care of " Plastics." 111–x9288

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FOR SALE, 8 cwt. Diakon moulding powder, various colours, at original price. Apply Box 3815, care of " Plastics." 111–3

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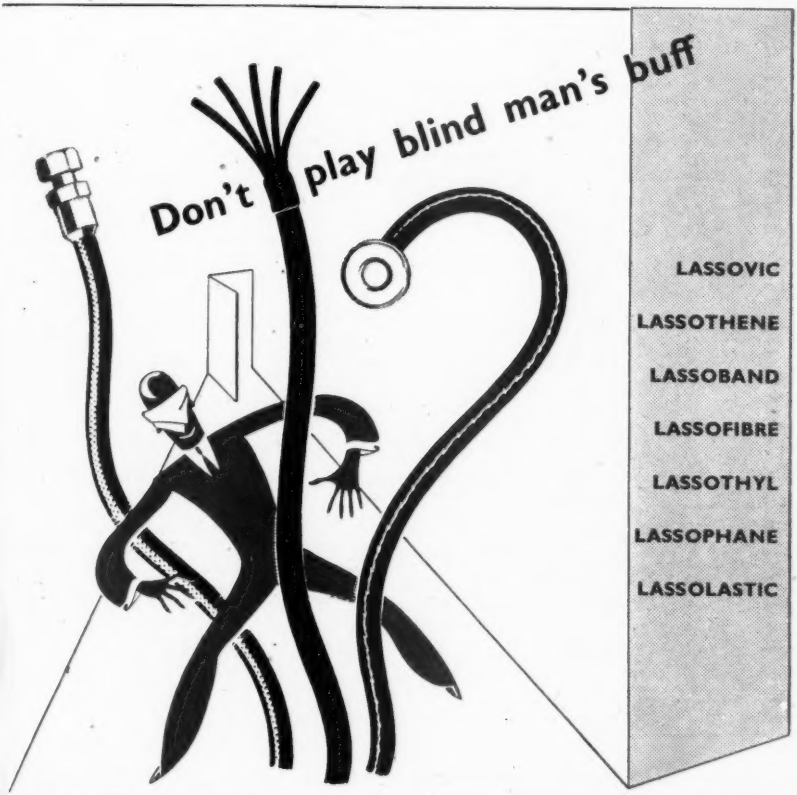

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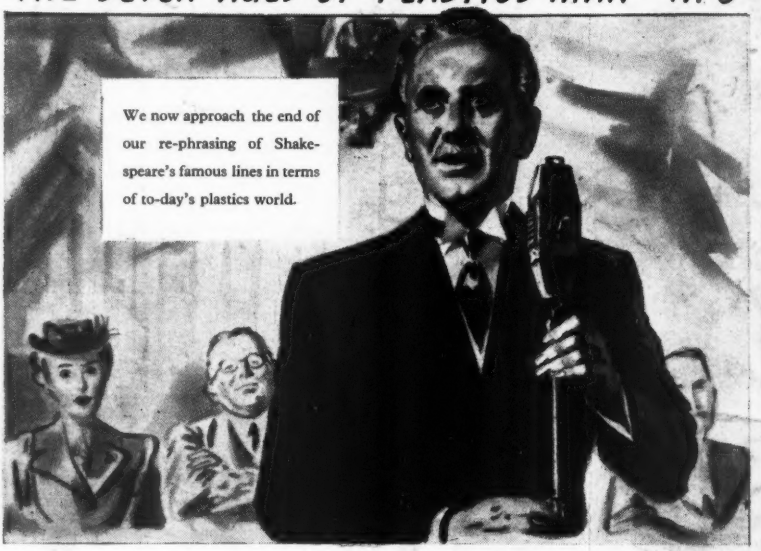
THE SEVEN AGES OF PLASTICS MAN – No. 6



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